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The NATURE AND CONDITIONS *of* LEARNING

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F. A. Moss, Ph.D., M.D., Editor

The NATURE AND CONDITIONS *of* LEARNING

THEOLOGICAL SEMINARY
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PREFACE

In this book learning is regarded as an active process through which the activities of the individual are altered in various ways. Changes in the tendencies and predispositions that control these activities are considered the immediate results of learning. This conception provides a unifying principle around which the products of research on learning are organized.

The treatment of the subject rests on the conviction that learning is the core of educational psychology, that laboratory research provides the most reliable data concerning the fundamental nature and conditions of learning, and that the educational psychology of learning must be based solidly on the fruits of the laboratory. It is believed, moreover, that for educational psychology laboratory findings must be supplemented by classroom studies on learning and also by interpretation that seeks to point out the meaning of the experimental evidence for educational practices.

An effort has been made to secure a balance of experimental evidence, illustration, interpretation, summary, and application. Illustrations are provided from everyday life and from the classroom to promote the comprehension of principles and to help bridge the gap between the research laboratory and the classroom. To make the work as authentic as possible with respect to the best thought and current trends in psychology, citations have been made throughout the book of primary sources and recognized authorities. Experimental evidence has been incorporated when it seemed important to the topic under consideration, regardless of the experimenter's interpretative point of view. Discussions of neurological theories of learning have not been included because they are not considered pertinent to the purpose of the book.

I wish to acknowledge here my indebtedness to all the psychologists whose names appear in the chapter references, particularly to my former teacher and esteemed friend, Professor Madison Bentley. Upon his teachings and writings I have drawn heavily; and although I have cited his writings many times by way of acknowledgment, this citation does not reveal the full weight of his influence nor the extent of my indebtedness to him for basic concepts and points of view.

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Many friends have contributed to the preparation of the manuscript. To all of them I wish to express my appreciation and thanks. The drawings for figures 1 through 6 were made by Marion B. Phinney. The graphs were drawn by Louise Pilley. For helpful suggestions, criticisms, and various forms of assistance in preparing and correcting the manuscript, I am particularly grateful to: Edith H. Kingsley, Lowell V. Kingsley, Alfred L. Moseley, Eleanor D. Herdman, Ruth N. Fletcher, and the editorial staff of Prentice-Hall, Inc.

H. L. K.

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PART I

INTRODUCTION AND THE FUNDAMENTAL NATURE OF LEARNING

CHAPTER I

INTRODUCTION

Learning and life. Learning is a fundamental process of life. Every individual learns, and through learning he develops the modes of behavior by which he lives. All human activities and achievements manifest the results of learning. Whether we regard life in terms of the race, of the community, or of the individual, we are confronted on every side by the pervasive effects of learning.

Through the centuries, the race has advanced because each generation has been able to profit by learning from the experiences and discoveries of the generations that have preceded it, and, in turn, has added its contribution to the ever-growing fund of human knowledge and skills. Customs, laws, religions, languages, and social institutions have been developed and maintained as a result of man's ability to learn.

We see the products of learning in the skilled performances of the builder, the engineer, the craftsman, the surgeon, and the artist. They are evident in the spectacular discoveries and inventions of modern science, in the thought of the philosopher, and in the decisions of the statesman. The everyday behavior of common people, their beliefs, their fears, and their adherence to tradition are determined largely by tendencies and predispositions acquired through learning.

As soon as a child is born, or possibly before, he begins to learn, and he continues to do so throughout his whole life. Within a few days he learns to call his mother by his cries. By the end of his first year he has become acquainted with many of the objects that make up his new world, has acquired a measure of control over his hands and feet, and has made a respectable beginning on the process of developing a spoken language. At the age of five or six he goes to school, where under direction he acquires habits, skills, information, and attitudes that society deems essential to good citizenship.

When we consider all the skills, interests, attitudes, and information acquired both outside and inside the school, and the relation of these to conduct, personality, and manner of living, we find learning to be a momentous and continuous feature of life. Through it man improves his performance of manual tasks, profits by his mistakes, and acquires knowledge of nature and an understanding of his fellows. It enables him to adjust adequately to his social and physical environment. We "live and learn," and by learning we may live better or we may live worse, but we are sure to live according to what we learn.

Although this volume is devoted primarily to school learning, it should be borne in mind that what a child learns in the classroom is but a part of all the learning that serves to mold his life and character. In developing habits, skills, understanding, and attitudes, the teacher must always build on the results of the child's previous learning, and this includes not only what he has already learned in school, but also the results of home training, community contacts, recreational activities, and experiences from a variety of sources beyond the classroom. The effective direction of learning in the school requires an understanding of, and an adaptation to, the undirected or less carefully directed learning from other sources.

Psychology and Learning

The subject matter of psychology. Psychology today is probably best defined in a general way as the study of the activities of the individual (14*a*).* The term *activities,* as used here, refers to all the things an individual does by way of interacting with his environment in the whole process of living. These activities appear in many forms. They include not merely what we do with our hands and feet or other larger muscles, such as walking, throwing a ball, or rowing a boat, but also such operations as observing an automobile passing by, noticing that our neighbor is having his house painted, listening to a lecture, recalling a name, solving a problem, studying a lesson, and planning a trip. Also included are such activities as enjoying beautiful music, resenting an offensive remark, rejoicing over good news, or lamenting a misfortune.

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* References are placed at the end of each chapter. Numbers in parentheses indicate the reference cited for credit, authority, or source.

Some of these activities that constitute the subject matter of psychology are complex; some are simple. They frequently overlap, and sometimes several go on simultaneously. There are acts within acts, or performances that are unit parts of larger units of activity. There is, therefore, need for a term that can be used to refer to any complete unit of activity we may wish to single out for study or description. Such a term we have in the word *function.* A systematic study of human activity reveals various types of functions.

The psychological functions: perception, memory, imagination, action, emotion, inspecting, searching, comprehending, elaborative thinking. One important set of functions includes the various observations we make by means of the sense organs, such as seeing a house, hearing music, noting the color of an apple, observing that the table is made of oak, or realizing by the sound we hear that rain is falling on the roof. These processes through which we become aware of present objects or transpiring events are collectively called *perception.*

We are not limited, however, to regarding present events and things. We are able to apprehend events as having taken place and to apprehend objects as things observed by us in the past. This we do when we think of the trip we took last week or of the scenes of our childhood. These functions through which we recall past events and experiences are called *remembering. Memory* is the term that stands for all the functions of this type.

Moreover, we anticipate future events; we conjecture, surmise, plan, daydream, and make suppositions. Such activities we call *imagination.* Then there are the motor activities, such as building a bridge, lighting a cigarette, sharpening a pencil, walking, speaking, or closing a window. Through them we work out our tasks or change our bodily orientation with respect to the physical situation. These motor functions constitute the group called *action.* The activities characterized by predicament, disorganization, inadequacies, heightened organic disturbances, pronounced feelings, and seizures of excitement (such as fear, anger, joy, or grief) are known as *emotions.*

The functions mentioned do not work independently of, or in isolation from, each other. They combine and fuse in many ways. The simpler forms of perceptive apprehension are enriched by *inspection.* This involves an examination or scrutiny of objects or situations in order to discover their nature more fully. The activity of *searching* goes a step farther. Here we have an active quest, an anticipatory exploration that is initiated and sustained by a desire or need to discover a particular object or goal. In searching there is a fusion of inspection and imagination. Slightly beyond inspecting and perceptive searching comes the function of *comprehending.* It involves various combinations of the functions already mentioned. Through it we acquire understanding. Next, and finally, we have *elaborative thinking* through which we create new knowledge, convictions, or solutions to problems by employing in appropriate ways and toward a definite end the functions of perception, memory, imagination, action, inspection, search, and comprehension in what is regarded as the highest and most distinctive of the adaptive processes of man (2).

The psychological functions and learning. The various psychological functions are initiated and controlled by the combined influences of three sets of factors. First, there are the *physical stimuli,* such as light patterns, sound waves, and other forms of physical energy presented by the individual's environment. In the second place, the basic character of the individual's responses to these stimuli is dependent upon *physiological structures* such as sense organs, bones, muscles, and nervous system. Since the bodily structures are primarily determined by heredity, their role in human activity has its origin in the individual's heredity. The third set of factors governing the psychological activities is derived from *learning.* This third set of factors includes the various *functional tendencies,* such as habits, thought trends, and attitudes, which have been developed by previous experiences, training, and practice. The particular form that activities take at any given time is due to these acquired functional trends laid down by previous activity. Any activity is learned in so far as it is governed by the results of antecedent functions (14*b*). This means that the psychological functions are developed and modified by learning. For this reason, the study of learning occupies a place of prominence in psychological research even aside from its value for educational practice. A survey of the great experiments that have featured the growth of modern psychology reveals that a strikingly large proportion of them have dealt directly with the problems of learning (6).

Learning is not another function. In our inventory of the psychological functions we did not list learning as one of them. Learning is not a unique function, separate and distinct from the others. It may take place in and through any one of them. For example, we learn to perceive, but we also learn *by* perceiving. The former is the case when any activity serves to make our perceptive functions keener or more effective. The latter is the case when our perceptions leave an impression that affects any subsequent function, be it imagination, memory, comprehension, elaborative thinking, or other perceptions. The only unique feature in learning is the intent to learn, and that, as we shall see later, is not always present when learning takes place.

Educational Psychology

Educational psychology is a branch of modern psychology devoted to the study of the psychological problems of education. It is directly concerned with the problems of growth, individual differences, and the development of personality. At the center of the field of educational psychology stands the subject of learning, because schools are established and teachers are trained and employed for the purpose of promoting and directing learning. Only through learning on the part of pupils and students can the aims of organized education be realized.

Historical background. Modern educational psychology is the natural outgrowth of two quite independent historical movements. One, known in the history of education as the psychological tendency, is marked by the efforts of certain educational reformers and philosophers of the eighteenth and early nineteenth centuries to "psychologize" education. Outstanding names in this movement are those of Rousseau, Pestalozzi, Herbart, and Froebel. Their teachings stressed the need for establishing educational practices upon psychological principles. They regarded education as a process of natural development taking place through activities initiated by the child's own impulses. This emphasis in education came before and presaged the advent of modern scientific studies of child development and behavior.

The second movement that opened the way for educational psychology was the rise of modern experimental psychology. This movement is marked by the application of scientific methods to the study of psychological problems. During the first half of the nineteenth century a number of experiments were made on sensation and perception. In 1879, Wilhelm Wundt established the first laboratory of psychology at the University of Leipzig (13), and by 1900 laboratories devoted to the scientific study of psychology had been established in most of the larger universities of this country.

The experiments of Ebbinghaus. The rise of educational psychology owes much to the pioneer work of the German psychologist, Hermann Ebbinghaus, in the field of associative memory. He was the first to devise methods for measuring the products of memorizing.

After several years of careful work, the results of his experiments were published in 1885 in a notable volume entitled *Ueber das Gedächtnis.*

To secure units of equal difficulty for purposes of measurement, it was necessary to use learning material as free as possible from meaning or previously formed associations. He met this requirement by constructing many hundreds of nonsense syllables, each one a meaningless combination of three letters consisting of two consonants joined by a vowel. Examples of such syllables are: keb, ruk, meg, cej. The device made possible the building of a series of any desired length with units of approximately equal memory value. With this type of material, Ebbinghaus investigated several problems of memory, retention, and recall. He memorized series of different lengths to discover the relation between the length of the series and the number of repetitions required for learning. He studied the relation of the number of repetitions of a series to the retention of that series. He devised the relearning method for measuring the retention for material that could not be recalled, and by means of it investigated the relation of forgetting to the length of the interval between learning and recall. He discovered many facts about the nature of the associations that are formed in learning. Since his time, his discoveries have been supplemented by the work of many other investigators, but his methods of measuring memory are still standard experimental procedures, and the results of his experiments are regarded as an important contribution to our knowledge of learning and forgetting (6*a*).

The situation in America during the nineteenth century. In America during the nineteenth century there was no educational psychology as a subject of instruction. Educational practices, as well as the curriculum, were based on the doctrine of formal discipline. Methods of instruction were formal and exacting. But toward the end of the century the influence of the European educational reformers was felt. A number of American students studied abroad and brought back to this country the educational theories of Herbart. The conviction that education should be based on laws governing the natural development of the child became prevalent among the leaders of educational thought. Thus, the way was prepared for the serious studies of child nature and the processes of learning that came later with the establishment of psychological laboratories and the employment of scientific methods for investigating psychological problems.

Beginnings of educational psychology in America. Edward L. Thorndike was the pioneer in establishing and organizing educational psychology in this country. Near the close of the last century he was engaged in experiments on animals. From these studies he formulated his famous laws of learning and his concept of learning by trial and error. His results first appeared in *Animal Intelligence,* in 1898. Thorndike saw the need and the possibility of promoting educational psychology by means of experimentation, and he devoted himself to this task. In 1903, he published a small volume entitled *Educational Psychology.* It dealt with the sources and measurements of individual differences and stressed the need for a scientific approach to the study of educational problems (10).

About this time, other American psychologists were making notable contributions, William James's book, *Talks to Teachers,* appeared in 1899. G. Stanley Hall's famous work, *Adolescence,* was published in 1904. James McKeen Cattell, who, like Hall, had studied under Wundt in Leipzig, was pioneering in the field of measurements and individual differences. Judd's *Genetic Psychology for Teachers* appeared in 1907. But the publication in 1914 of Thorndike's *Educational Psychology,* in three volumes entitled: (I) "The Original Nature of Man," (II) "The Psychology of Learning," (III) "Work, Fatigue, and Individual Differences," really marks the beginning of educational psychology as a distinct and systematized subject. In his introduction to these volumes, Thorndike acknowledged his indebtedness to his teachers, William James and James McKeen Cattell, and to G. Stanley Hall. Within the volumes, he refers frequently to the investigations of the European scholars. Recognition is given to the studies on learning of Ebbinghaus and Meumann in Germany, to Galton's studies in England on individual differences, and to Binet's studies in France on fatigue.

Thus, educational psychology has sprung from the recognition of the need for basing educational practice on sound psychological understanding and from the adoption of the experimental approach to the study of psychological problems. Many scientifically minded investigators have contributed to its development. It stands today as an important branch both of education and of psychology.

The aims of educational psychology. The general aim of educational psychology is to discover by reliable methods of investigation whatever psychological knowledge will be valuable to the teacher and educator and to make this knowledge available, so that instruction may be made as effective as possible. It seeks, not to formulate methods or techniques of instruction, but to establish sound principles of human nature, child development, and learning upon which efficient teaching practices may be built.

Educational psychology does not assume the task of determining the aims of education. These aims must be established in the light of our social philosophy and the ultimate needs of the individual. The decision regarding what they shall be is the task of the educational philosopher. But, with educators agreed upon a set of educational objectives, it is the purpose of educational psychology to provide reliable information that will aid in successfully reaching the desired ends.

More specifically, educational psychology aims to supply the teacher with knowledge of the nature of his pupils. It seeks to show how children differ from one another, what part heredity plays in determining ability to learn, what part instruction and other school influences play in the development of the child, the nature of the process of learning, the different forms of learning, the influences that promote or retard learning, and how the outcomes of learning may be evaluated. It seeks, also, to establish a scientific attitude toward educational practices, so that demonstrated facts will be sought and valued above unreliable opinions, and to provide insight into the nature of the educative process, so that teaching procedures will be based on understanding rather than merely on imitation. It endeavors to secure an appreciation of the child as an individual and to develop the problem-solving attitude toward the problems of instruction.

Psychology and teaching. The study of psychology is considered an essential part of every teacher's training today. Teaching is not a rule-of-thumb procedure. The teacher must be able to meet new situations with new and appropriate tactics. He must be able to adapt himself to new conditions. He must be open to new suggestions, willing to adjust to advances, but able to detect unsound proposals. Such versatility and soundness of judgment call for fundamental knowledge. Psychology is the basic science of the teaching profession. Other qualifications besides a knowledge of psychology are essential for successful teaching, but the study of psychology and its proper application should enable a teacher to be more adaptive, more versatile, more creative, more understanding of children, and more successful in working out his problems. It should enable him to formulate teaching procedures appropriate to the interests, needs, and abilities of his particular pupils. He cannot afford to rely upon a few devices or techniques acquired by imitation, for a device or method used successfully by one teacher may not be successful in the hands of another, and a teaching procedure adequate in one teaching situation may be entirely inappropriate for another.

Teaching methods are devices for securing learning on the part of pupils. To be effective, teaching methods must accord with the principles of learning. To stimulate and direct learning effectively, the teacher needs to understand the nature of the learning process and the factors that influence it. Learning takes place only through the active responses of the pupil, and responses to classroom instruction depend quite as much upon the nature of the child as upon the character of the instruction. It is as important for a teacher to know child nature as it is for a physician to know the physiology and anatomy of his patient.

Psychology and the curriculum. The decision concerning what the pupils in our schools should learn is not primarily a psychological problem. What subject matter shall make up our courses of study is a question to be answered by the educator in the light of the immediate and ultimate educational objectives. The selection of material for the curriculum must be based on a consideration of what knowledge and skills are most valuable in meeting the future needs of the pupil. The political and social philosophy to which the people are committed and the traditions they wish to perpetuate will be important considerations.

However, the developments in modern psychology have had considerable influence on the curriculum. One striking example is to be found in connection with the history of formal discipline. This doctrine of formal discipline was based on the now discredited "faculty psychology," according to which the mind consisted of a set of faculties or powers, such as judgment, reason, memory, will, and imagination. The task of education, it was believed, was to train these mental faculties. The content of the subjects taught was regarded as of little importance. During the eighteenth and nineteenth centuries the curriculum of the secondary schools consisted almost entirely of Latin, Greek, and mathematics, because these subjects were regarded as highly effective instruments for training the mind. But as a result of the discoveries made by experimental psychology, an account of which is given in the final chapter of this book, the old faculty psychology has been rejected and the doctrine of formal discipline has been discredited.

The effects on education have been most noteworthy. During the last twenty-five or thirty years we have seen the classics lose their grip on the curriculum. Colleges have dropped the Latin requirements. In the secondary schools there has been a shift of emphasis to the sciences and social studies (8). Vocational subjects have been introduced and have won a respected position. In the elementary schools the subjects have been sifted. Useless material once included with the idea that it trained the mind has been discarded. The material retained has had to prove its usefulness (11, 12). Thus, a change in the conception of the mind and a better understanding of the effects of training have resulted from psychological experiments, and this change, in turn, has been of far-reaching influence in settling the question of what the child should learn.

Another recent development in education that has been prompted, in part at least, by the research in modern psychology is the more adequate provision within the curriculum for individual differences. The use of psychological tests has revealed that in any group of school children there is a variety of interests and possibilities and a wide range of differences in capacity for learning. These findings have indicated the need for different types of courses of study and more flexibility within the curriculum. The result has been a greater diversification of offerings to meet individual requirements. With this development has arisen the need for educational guidance. The guidance counselor must take into consideration such psychological factors as the child's mental ability, his interests, and his personality traits.

Contributions of psychology to education. Through its employment of experimentation and other scientific procedures, modern psychology has during the past fifty years contributed to education a considerable body of reliable information concerning the nature of the child and the learning process. The practical result of this scientific knowledge has been a number of important changes in educational theory and practice. Teaching methods, as well as the content of the curriculum, have been changed as a result of the studies that led to the abandonment of the old doctrine of formal discipline mentioned in the preceding section. We now believe in teaching for transfer to life situations. The old practice was to require exact mastery of material, regardless of its usefulness, for the purpose of training the mind.

Child nature. Before the time of Rousseau (1712–1778) the child was generally regarded as inherently bad and as possessing on a smaller scale substantially the same traits and characteristics as the adult. Strict discipline to curb the evil tendencies was the accepted practice in education. Rousseau, too, regarded the child as a little man, but he held that the child was by nature good. From his theories developed a movement that stressed freedom and self-expression in education, and in some instances the programs carried out under the influence of this thought were excessive and ridiculous (1).

In recent years notable progress has been made in child psychology through many scientific studies of the behavior and development of infants and children. This research has given us a better understanding of child nature, and has shown us that the child is not simply a small edition of the adult pattern. It is evident now that he differs from his elders qualitatively as well as in size. Moreover, the child is regarded now as neither inherently bad nor inherently good. We see him possessing the possibilities of developing into an adult. He may *become* good or bad according to the traits and tendencies he develops through his experiences and training. This modern view has led to a balance between discipline and freedom in educational practice and to a revision of educational aims and methods. We believe now in guided development.

Modern research on the nature of child development has led to the virtual abandonment of the old doctrine of instincts in human psychology. According to this doctrine a large part of the child's behavior was directly inherited and appeared without benefit of learning at the appropriate stages of growth. We are convinced now that most, if not all, of the behavior that was formerly regarded as instinctive is not inherited at all, but that it is the result of learning, and particularly of learning that occurs in preschool years. This change of view has served to underscore the significance and importance of the child's early environment and training (5).

The course of development. In the past the development of the child was believed to follow an irregular course with spurts or periods of rapid advance alternating with periods of little or no progress. The various "mental faculties" were supposed to bloom at different stages in the child's growth. Childhood was regarded as the golden age of memory, and reasoning was believed to appear only when adolescence was reached. Modern studies have shown that the child's development is, for the most part, continuous and gradual. We know now that memory and reasoning both develop throughout childhood. In keeping with this modern understanding of child development there has been provided a more gradual transition from the elementary school to the high school by means of the junior high school and departmentalized work in the upper grades; and in the elementary school the old stress on memory work has been considerably reduced in favor of more activities that stimulate thinking.

Personality and mental hygiene. The older psychology was concerned mainly with the intellectual processes, and education reflected this emphasis by stressing the training of the intellect with little consideration for the other components of personality. Recent developments in psychology have shown the importance of the emotions. It is evident that man is not moved primarily by rational considerations and that the feelings and desires are the great motivating factors in human behavior. The need for educating the emotions as well as the intellect is now recognized.

Tied up with emotional life is the important matter of mental health. Studies in abnormal psychology have indicated the need for mental hygiene in education, and today educators are accepting the responsibility for safeguarding the mental health of pupils by fostering wholesome habits of dealing with annoying and troublesome situations.

Recently, gratifying progress has been made in the study of personality, and this, too, has had its influence on education. There is a growing acceptance of the view that the school should foster the wholesome development of the whole personality of the child, and this means the promotion of his physical, emotional, and social well-being as well as the training of his intellect (9).

Individual differences. Numerous studies of the extent and causes of individual differences have served to define more clearly the respective contributions of heredity and environment to individuality. From these studies we have acquired a better understanding of the influences of sex, age, nationality, and race as sources of differences. With respect to the development of personality traits particularly, we now attribute relatively less weight to the determining influence of heredity and relatively more to the influence of environment than was done a few decades ago. For education, this change implies greater opportunity and greater responsibility for the modification and development of traits of personality.

The studies of individual differences also have shown that children of any age or grade differ widely in ability to learn. As a result of the fuller appreciation of this fact, various attempts have been made to adapt instruction to the differences in ability within the classroom. It has been established, moreover, that an individual tends to maintain his relative level in intelligence and in school achievement. This fact has made educational prediction possible to some extent—a matter of importance to the educational and vocational counselor.

Standardized tests. One of psychology's greatest contributions to education is the development of objective standardized tests of intelligence, of achievement in school subjects, of aptitudes, and of personality traits. These tests have been useful tools in psychological research, in classifying pupils, and in diagnosing learning difficulties and deficiencies. They have made it possible to estimate objectively a pupil's ability to learn. Through their use a supervisor may compare the progress made by different classes, and the administrator may objectively appraise the accomplishments of his schools. Psychological tests, properly used, enable the teacher to discover many things he should know about individual pupils. For the guidance counselor their use provides information needed for wise counseling.

Learning. In an account of the great experiments that have practically made modern psychology, Garrett (6) describes fifteen major contributions. Of these, seven are studies on the nature of learning and the factors that govern it. These seven are: first, the studies of Ebbinghaus in the field of memory and forgetting; second, Pavlov's work on the conditioned reflex; third, Thorndike's experiments on animals, from which he formulated his laws of learning; fourth, the experiments of Thorndike and Woodworth on transfer of training; fifth, Watson's experimental studies of the behavior of infants, including the conditioning and unconditioning of emotional reactions; sixth, Köhler's experiments on perception and animal learning; and seventh, the investigations by Franz and Lashley on the role of the brain in learning. The work of these outstanding psychologists has been extended by scores of other experimenters, many of whom have investigated learning in children under laboratory conditions and in the classroom.

Although much of this research on learning, particularly that conducted in the laboratory, has been done by psychologists from a purely scientific point of view and without regard for the educational implications of their findings, it has, nevertheless, added greatly to our understanding of the learning process and, therefore, has made a most important contribution to educational psychology. The value of this work for education is apparent when we consider that the success of all educational endeavor depends upon the learning that it secures on the part of pupils and students. The better we understand the learning process, the more intelligent and effective should be our efforts to promote and direct it. In the chapters that follow we shall be concerned with the products of research on learning and their educational bearing.

METHODS OF RESEARCH IN EDUCATIONAL PSYCHOLOGY

The advances in our knowledge of the psychological principles underlying successful educational practices have come from the application of scientific methods of investigation to the problems of human nature and learning. Ordinary observations have proved to be insufficient. They are usually unsystematic, and the conclusions or opinions derived from them are too often confused or distorted by preconceptions and emotional bias. The scientific investigator must be a trained observer, impartial toward all facts, and thoroughly systematic.

The methods of investigation employed in educational psychology are of two general types: first, nonexperimental; and second, experimental.

1. Nonexperimental methods. In research studies employing these methods, the aim is to discover the existing facts regarding the matter investigated. No attempt is made, as in experimental research, to control or manipulate the situation. The matter is explored in order to bring to light the factors, conditions, or relationships present. This type of research has been called *descriptive* because it studies and describes the situation as it is.

a. The questionnaire. In the case of the questionnaire method, the investigator first formulates a set of questions aimed to secure the desired information. These questions are then submitted to a large number of persons, selected on the basis of suitability for the study. The answers thus obtained constitute the raw data from which conclusions are derived.

This method, because of some inherent weaknesses, is not considered a first-rate scientific procedure. There is the danger of unreliability of the data because the subject may misinterpret the questions or answer inaccurately on account of ignorance or untruthfully because of a desire to make a good impression. There is also the danger of one-sided data due to the return of too small a proportion of the questionnaires. If only half the persons solicited return their answers, these answers cannot safely be used as the basis for conclusions regarding the whole group. The very fact of a partial return indicates some selectivity, due to a difference between those who answered and those who did not answer. It is generally considered that at least seventy-five per cent of the questionnaires must be returned if the answers are to be used for making valid generalizations.

However, the questionnaire has its place when used with discretion. It has been fruitful in making surveys of opinions and interests, and it has been the means of collecting valuable data, when no other method was available. The Government uses this method in checking up on our incomes. The questionnaire may be used to find out many things that enable the teacher to know his pupils better. Such facts as age, name of parents, number of brothers and sisters, vocational interests, and the like usually may be secured for the asking.

A modification of the questionnaire method that avoids some of its drawbacks is the questionnaire-interview. A set of questions to be asked is carefully drawn up. Then the investigator personally interviews the subjects, asks the questions orally, and writes down the answers in a form suitable for statistical treatment. This method was used successfully in a study of race prejudice when many of the subjects could not read or write English (7).

b. Tests and statistics. A more objective and more reliable method for descriptive research is found in the use of tests and statistics. The tests employed in this method are usually of the objective, standardized type, such as those used to measure intelligence, school achievement, personality traits, or physical characteristics. The scores from these tests are interpreted by means of refined statistical procedures.

Statistical treatment of test scores reveals many significant facts regarding the group tested. The mean of the scores tells something of the standing of the group as a whole. The median shows the point or score above which the upper half of the group falls and below which the lower half falls. The average deviation and standard deviation indicate the degree of variability within the group. Correlation coefficients provide a measure of the extent to which the various individuals of a group tend to get the same rank in two different tests. These, with other statistical devices, make possible precise and trustworthy analyses and interpretations of the data collected by means of the tests.

In the experimental methods and in case studies, tests of various kinds are often employed, and some statistical procedures are used in analyzing the data obtained from questionnaires and experiments. In presenting the use of tests and statistics as a method of research in itself, reference is made to those procedures in which testing and the statistical treatment of test scores are the essential and primary features of the investigation.

The use of tests and statistics has helped to solve many of the important problems of educational psychology. The whole field of individual differences has been explored by this means. Studies have been made of such questions as the relation of scholastic achievement to mental ability, the influence of home conditions on personality traits, and the extent to which excellence in one school subject corresponds to high standing in other subjects. Tests and statistics have served the purpose of making surveys of school systems, of judging the outcomes of learning, and of determining the extent of variability within classes. Their use has revealed the extent of sensory defects in our school population, the nature of mental growth, and the relative usefulness of various phases of arithmetic. A complete list of contributions to our knowledge made by the method of tests and statistics would be a long one.

c. Clinical methods. As valuable as are the findings regarding the status of a group derived from questionnaires or tests, and the knowledge of the characteristic features of human behavior obtained from experiments, these are not sufficient for understanding an individual child's particular difficulties and needs. Each child's personality presents a unique constellation of a large number of traits, and the product of a great variety of hereditary, environmental, and training influences. Likewise, his behavior is the result of a complex of motives and circumstances. If a child is a behavior problem, or is maladjusted educationally, socially, or emotionally, adequate treatment calls for an understanding of the factors that have contributed to his particular difficulty. The clinical method provides a diagnosis of the underlying causes of misbehavior or maladjustment. It rests on the conviction that treatment should be concerned with *causes* rather than *symptoms.*

When a child is brought to a psychological clinic, he is given various tests to determine his physical, intellectual, and educational status. The record prepared usually includes a case history. The data for the case history are obtained from a variety of sources. Parents are usually interviewed, in an effort to find out as much as possible about the child's home background and the relations between him and the other members of his family. The record will include whatever can be learned concerning the parents' attitudes toward the child, their treatment of him, his sickness history, his emotional disturbances, and his companions outside the home. The child's teachers probably will be consulted for information concerning his school life. Of particular importance for a case history will be facts concerning his attitude toward his work and toward other children, his success or failure, his conduct in school, and his emotional stability. If he has a court record, that, too, will be investigated. These and any other available facts concerning the child's history that may have affected his personality or his behavior are assembled in his case history.

A careful analysis of such data is essential for a clear understanding of the problem child, the misfit, or the failure. Such a study frequently reveals the fundamental cause of the undesirable behavior or maladjustment. By removing or altering this cause, a more adequate adjustment may be effected. The discouraged, failing child may be encouraged and put in a position to succeed; or the misbehaving child may be provided with a more socially acceptable way of satisfying his needs.

Although the treatment of individual difficulties is the primary purpose of this method, the data from clinical tests and case histories have thrown much light on many general problems of psychology. Here are revealed the concrete workings of the complex tangle of conditions that determine human behavior. From the mass of evidence gathered by this method, it is clear that misconduct has definite causes and that it can be treated effectively only by discovering and removing the causes. Delinquency is usually the result, not of depravity, but of unwholesome environmental factors and emotional conflicts. Disabilities in school subjects are due, not merely to laziness or lack of intelligence, but to a variety of conditions that conspire to prevent the child's normal success.

d. The genetic methods. These methods involve a series of planned and systematic observations of a child's behavior over a considerable period of time to discover the nature of his development. In child-study centers of a number of our universities, such observational studies have been made of the growth changes in infant and child. Records are made day after day, for weeks and sometimes years, of such activities as prehensile movements, manipulation of blocks and toys, emotional reactions, and responses to other children. Sometimes a one-way vision screen is used, so that the observer can watch the child at play without the child's seeing him. Motion pictures have been used to great advantage in these studies. They provide a permanent record of complex reactions that may be analyzed on the projection screen and studied in detail by the observer at a later time. Such pictures have been made of a child's reactions to similar situations at different ages. When these pictures are compared, the growth changes in motor coördination are clearly revealed. Frequently, experimental procedures are introduced by controlling and modifying certain conditions in the child's environment, to determine how such changes will affect his behavior.

These studies have yielded a better understanding of the principles of child development. It has been found that abilities and traits tend to appear at about the same age in different children. Because of this fact, it has been possible to establish norms of development by determining how normal children usually react to certain situations at various ages.

From these observations, also, we have learned that: first, growth, physical and mental, is a gradual and continuous process that may be facilitated or inhibited; second, it proceeds most rapidly in the early years of life; third, various physical and mental traits grow at different rates; fourth, in the development of behavior, specific responses usually emerge from mass or diffuse behavior; and fifth, the effects of specific training are limited by the stage of growth that a child has reached.

2. **Experimental methods.** The most exact and refined methods of research are to be found in the scientific experiment. There are two kinds of experimental studies that have served the cause of educational psychology well. They are: first, laboratory experiments; and second, classroom experiments.

a. The laboratory experiment. In the laboratory experiment the problem to be investigated is usually reduced to relatively simple terms, or, if it is a complicated matter, a part of the whole problem is undertaken at one time. For example, action has been studied in the laboratory in the form of the simple reaction, which consists of pressing down a key with a single finger in response to a light or sound signal. *Simplification* avoids many of the hazards involved in trying to observe a more complex performance and makes possible the study of essential elements.

In a well-conducted experiment the experimenter sets up and *controls the conditions* under which the observations are made. He observes the effects resulting from a change made in one of the conditions while the others are held constant. This control of conditions is the core of the experimental procedures. It is made easier by simplification of the problem, for that reduces the number of elements in the situation to be controlled. If, for example, we wanted to determine by experiment the influence of temperature on the ability to add, we should have to set up the experiment so that our subjects would do addition problems under various temperatures while all the other conditions remained identical. Light, humidity, time of day, duration of the work period, difficulty and type of problems must be the same if we are to isolate the influence of temperature. If there were other variables in the situation, they, instead of the difference in temperature, might be responsible for any difference in the number of problems solved.

In psychological experiments it is very difficult to control all the conditions, particularly those within the subject. Such factors as attention and feelings are not easily restricted to prescribed channels. The psychological experimenter controls these subjective factors as far as possible. Careful instructions are given to secure the proper attitude and the right mental set. Practice and fatigue effects are balanced to neutralize their influence on measured results. The experiment usually is repeated many times and with many different persons as subjects. The average of many observations is computed. This serves to neutralize most of the effects of uncontrolled factors within the subjects themselves.

A good experimenter, moreover, is alert to all that happens during an experiment. His records are made at the time of the observation to avoid errors of memory. He seeks to test his hypothesis, not to prove it. His observations are refined and his data made more reliable by the use of instruments. Chronoscopes measure time intervals for him in units of 1/1000th of a second. Kymographs make graphic records of breathing or pulse changes. The motion picture camera makes permanent a record of a complex bit of behavior, so that later it can be studied deliberately and in detail. Exposure apparatus mechanically presents learning material at a uniform rate and with equal time intervals. Finally, when the experimenter publishes his findings, he describes his procedures fully so that other investigators may repeat his experiment and verify his results.

The fundamental principles of learning have been derived, for the most part, from laboratory experiments. Such were the memory experiments of Ebbinghaus, the studies on animal learning by Thorndike, and the experiments on the conditioned reflex by Pavlov.

The advantages of laboratory procedures are found in the precision of observation that they afford and in the consequent reliability of the data secured by their use. But there is something artificial about the laboratory setup that renders it unsuitable for investigating certain kinds of problems. This method could hardly be used, for example, to study the cross currents of social influences and emotional reactions which affect an individual's behavior in a political campaign or in a battle. It would be difficult to conduct an experiment on the emotions of a youth falling in love. We depend upon the laboratory for our fundamental knowledge of learning, but we need to study classroom learning in classroom situations. There are some important differences between learning a list of nonsense syllables in the seclusion and quiet atmosphere of the laboratory and memorizing the words of a new song with forty other children under the direction of a teacher.

b. Classroom experiments. In the classroom there are hundreds of uncontrolled variables. The children differ in interests, abilities, physical conditions, and countless other ways. They do not react alike to the teacher. Distractions intrude that are unpreventable and unforeseen. Yet we need to know how certain conditions or procedures tend to influence the learning success of pupils in just this situation. The experimental procedure for making such studies is called the *method of parallel groups.*

In this procedure there are always at least two groups of pupils. One is the experimental group; the other, the control group. These groups are equated on the basis of preliminary tests for age, mental ability, background, and so forth. Where there is a range of differences in both groups, they may be equated by matching each pupil in one group with another of like circumstances for the other group. Having thus secured two equal groups, the procedure or condition that we wish to test is used for the experimental group, while the control group that is to serve as a means for comparison goes on without it. Differences in results may then be attributed to the factor present in the experimental group but absent from the control group.

This method of experimentation has proven valuable to educational psychology because it can be used to study the relative merits of teaching procedures in actual classroom situations. A study of the efficacy of supervised study in which this method was employed was made several years ago by the Michigan Schoolmasters' Club. Fourteen high schools in Michigan coöperated in the experiment. Two sections of the same grade and subject were equated for size and ability. For section A, the experimental group, the period was divided, with thirty minutes devoted to supervised study and the balance to recitation. Section B, the control group, spent the entire period in recitation. The groups were tested at the end of six weeks and again at the end of twelve weeks. In plan I one teacher taught both sections, but at the end of the six weeks' period the sections were reversed so that B became the supervised-study group, and A became the control group spending the whole period in recitation. In plan II two teachers were used. Section A continued as the experimental group with supervised study, and B served as the control (all recitation) for the twelve weeks of the experiment. But in this plan, the teachers changed sections at the end of the first six weeks. The switching of sections in the first plan and the changing of teachers in the second served to balance the effect of uncontrolled variables.

Data obtained for 596 pupils from thirty-four classes and in three subjects indicated a difference in the value of supervised study for different subjects and for different levels of pupil ability. In first-year algebra and in ninth-grade English composition the advantage was on the side of nonsupervision, but in first-year Latin better results were obtained in the supervised-study groups. The poorer students in general profited by supervised study, whereas the brighter students were retarded by it. As a result of the study, it was recommended that supervision of study be concentrated on the poorer students and that the techniques of supervised study be improved (3). Many such carefully planned and controlled investigations have helped to put educational practices on a more scientific basis.

Summary of the Chapter

Learning is a universal feature of all human and animal life. Through it civilization has been developed; and by it laws, languages, customs, traditions, science, and philosophy are maintained, modified, and transmitted from generation to generation. Through learning the individual acquires knowledge, habits, skills, and attitudes, both in school and out of school.

Modern psychology is a scientific study of the activities by means of which the individual deals with his environment. The psychologist is concerned with the formation and modification of activity patterns and tendencies. Since learning is the process through which activity trends are developed and modified, the investigation of learning is an essential task of psychology.

Educational psychology has developed from the realization of the need for organizing educational procedures on psychological principles. Ebbinghaus, Meumann, and Thorndike were important pioneers in promoting the development of this branch of psychology. It aims to provide the teacher with sound information concerning children and insight into the learning process that will enable him to carry on his work most effectively. It does not attempt to set up the aims of education, but it does seek to discover the basic principles governing the achievement of adopted aims. Its contributions are primarily in the field of teaching methods.

Professional training includes a study of the sciences basic to the practice of one's profession. Psychology is a fundamental science for educational practice. Fundamental knowledge makes possible better practice. It stimulates progress and increases adaptability.

Although the determination of what subjects shall be placed in the curriculum is not primarily a psychological problem, developments in psychology have had important influences on the curriculum. Changed views on the nature of mind and mental training have led to a shift in emphasis from the classics to the natural and social sciences. Studies in child development have influenced the selection and placement of subject matter.

Organized education seeks to promote certain kinds of learning.

Psychology has contributed to education helpful knowledge concerning the nature of the learner and a better understanding of the learning process and the conditions that govern it.

The nonexperimental methods of research in educational psychology are: first, the questionnaire; second, tests and statistics; third, clinical; and fourth, genetic. The experimental methods include: first, laboratory experiments; and second, classroom experiments.

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CHAPTER II

THE NATURE OF LEARNING

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ESSENTIAL FEATURES OF ALL LEARNING

All learning takes place through activity. We shall approach our discussion of the fundamental nature of learning by way of a few typical examples drawn from everyday life and representing different forms of learning by different types of individuals. It will be noted that, despite their diversity, the cases have certain features in common. The isolation of these common features will be the initial step in the formulation of a comprehensive working concept of learning.

Animal learning. A dog wants to leave the house but he finds his way blocked by a screen door. He pushes against the door with his nose, and then with a front foot; he paws at the lower part of the door; but it does not open. He whines and moves about in an agitated manner. Finally, he rears on his hind legs, planting his forefeet against the door well above the floor. As he moves about, one paw by chance strikes the latch and releases the fastening. The dog's weight against the door causes it to swing open, and out he dashes. With a few repetitions of this situation the behavior of the dog changes. He soon singles out the latch and when he wants to leave the house, we see him approach the door, rise immediately on his hind legs, release the latch with a direct thrust of a forepaw, and go out. His procedure is now calm, direct, and well adapted to cope with the situation. The useless reactions that were so pronounced a feature of his first performance have disappeared. He has learned how to open the door.

An infant learns. A baby cries because he is hungry. He is taken up, petted, and fed. He enjoys the attention as well as being fed. Soon he cries when he wants to be taken up even when he is not hungry.

Acquiring a motor skill. A boy of eight years has just received a pair of skates for Christmas. He is anxious to try them out. He has never had skates on his feet before, but in his eagerness he assumes that it must be very easy to skate. He observes how swiftly and smoothly the other fellows skim around the pond. With considerable effort he finally gets the skates on his feet. He stands up on the ice. Ankles wobble. He teeters forward. One foot starts off by itself, quite out of control. Hands fly up, but there is nothing to grasp; so down he goes with a bump. Undismayed he tries again. On his feet, he tries to go ahead. Cautiously he pushes one foot forward a bit. His whole body is tense. He teeters. Unsteadily the other foot is drawn up. He is using, or attempting to use, the movements which have served him well in walking. In this awkward and hesitating manner he creeps forward a few feet. He has courage. It is fun even if he does fall down frequently. As he continues his efforts, we see him improve rapidly. He discovers how to turn his foot outward so that he can push himself forward on the other foot. Coördination of movements and balance are developed rapidly. In a few days he is skimming over the ice, making rapid turns, playing hockey with the other fellows in what appears an utter forgetfulness of his feet. They just seem to take him around wherever he wants to go as faithful, obedient, efficient, unquestioning servants.

A poem is memorized. A girl in the eighth grade has been asked by her teacher to memorize a poem. She has brought the book home and is now sitting at the table in the dining room. She has her book open to the poem. The teacher had read the poem to the class at school. It sounded beautiful as the teacher read it and explained all the hard words. The girl now understands what it means and is anxious to be able to recite it. She reads over the first two lines three or four times, looks up, and tries to say them without looking at the book. At the end of the first line she can't think how the second one begins. She glances at the first word of this line. That starts her off. She completes the line without reading. The next time she gets through both lines without looking at the book. She repeats them over aloud three or four times just to be sure she has them so she won't forget. After these can be recited she goes on to the next lines and continues reading, reciting to herself, prompting herself when she cannot remember, and repeating until she is able to recite unhesitatingly the whole four stanzas without the book.

Information is acquired. In his home room in high school a boy is preparing his American history lesson. He is bent over his book, reading. His eyes move back and forth as they pass along from line to line. His lips move a bit. He pauses and makes a few notes with his pencil. Later when he goes to class, the teacher asks a question about the reconstruction period in the South just after the Civil War. She calls on this boy and he tells about the carpetbaggers, though he knew nothing about them before he studied this lesson.

Understanding is developed. In college a student is listening to a lecture on genetics. She hears for the first time the word *mitosis.* She writes it down in her notebook and follows the professor's explanations attentively. She copies the sketches he puts on the blackboard. A point is not clear. She asks the instructor to explain it. She understands the explanation, and as she leaves the room, she has many ideas related to the term *mitosis* that make clear to her the nature of the process of cell division. Later, in the examination, a question calls for an explanation of *mitosis.* As she sees the word, not all, but many of the things she heard that day come to her mind and she is able to write a passable answer to the question.

Common features. These examples represent different kinds of learning, but not all the varieties we shall have occasion to consider. Though different, they have two features in common: First, the learning took place through activity; and second, the result was a new kind of performance or a change in the form of activity. Moreover, these two features will be found in all other cases of learning. They mark the essential nature of all learning. Whenever one learns, he does something; whenever one learns, his manner of reacting, his performance, his activity is modified.

Views and Definition

Learning as modification of behavior. Learning is frequently described as a process through which behavior is modified (5, 6*a*). This, it will be noted, is true for each of the cases of learning described in the foregoing section. The behavior of the dog was definitely changed as a result of the learning experience. The child, after memorizing the poem, recited without the aid of the book, truly a new accomplishment in the way of behavior. The young lad's skating improved. The high school boy's recitation and the college student's writing during her examination likewise exemplify new or modified forms of behavior resulting from learning.

Learning as functional modification. While it is true that learning does serve to modify behavior, it does not follow that all learning is modification of behavior unless the term *behavior* is construed to cover all the psychological functions, including perception, emotion, and the thought processes, as well as the motor functions. No doubt this is the intention of most writers who define learning in this way. But since to some persons the term *behavior* may not have such a broad connotation, Bentley's statement that learning is "functional modification" seems to be better suited to cover all forms of learning (1*a*).

Learning as the modification of functional tendencies. The activity by which learning is achieved cannot directly change functions which follow it. Its direct effect is a change in the individual, and because he is changed by this activity, he reacts differently to the same external situation when he encounters it again.

It is generally assumed by way of *explanation* that the link between the activity which serves to modify and the modified activity which follows is some change produced by the former in the neural structure which governs the functions (25). For purposes of description we shall be content to regard the immediate effects of learning activity as changes in the *functional tendencies.*

Learning as improvement. In speaking of the modification of functions by means of learning some writers have stated that if the change is to constitute learning, it must result in the *improvement* of behavior. This is, of course, a common conception when one is thinking of the learning that takes place in the classroom according to the wishes and intent of the teacher or where one engages in learning for a definite purpose. As one's performance is molded so as to approach the goal of excellence or skill toward which his efforts are directed, to think of the process as the improvement of performance seems appropriate enough.

But improvement usually connotes enhancement of value. It seems hardly possible to conceive of *all* learning as improvement in this sense. If improvement is to be taken as meaning the fixation and consolidation of performance, good or bad, so that the performance is carried through with greater dispatch and ease, with greater certainty, then and only then, can we say that all learning constitutes improvement. Sheer negative change, through deterioration of function caused by fatigue, could not be considered learning. But positive change of governing tendencies, which results in bad habits, the fixation of error, and undesirable attitudes, is quite definitely learning, and it seems difficult to consider this kind of learning as improvement. The child learns many things in the classroom that do not fall within the range of the teacher's objectives. He may learn habits of idleness and disrespect for authority. He may learn to write more poorly or he may acquire habits of poor reading. If improvement is to mean an approach toward the more desirable, we cannot restrict our concept of learning to this criterion.

Learning as adjustment. Learning has been described as a process of "progressive adjustment" to the ever-changing conditions which one encounters. To *adjust* means to bring into proper relations. When the individual is out of adjustment with the conditions of life, he is disturbed, unsatisfied, and unhappy. There is lack of harmonious functioning. Through learning he is able to make adjustments. He acquires new ways of behavior that bring him into harmonious relations and secure for him the desired satisfactions.

But it must be noted that a child frequently adopts modes of behavior that are definitely maladjustive. He may acquire emotional habits detrimental to his mental health, habits of conduct that get him into trouble with the authorities of the school or state, and attitudes that cause failure in schoolwork. Even in school he may be taught to aspire to goals beyond his ability to attain. When the domestic science course teaches the girl to cook and buy in a manner not suited to the budget within which she must operate, it is maladjustment rather than adjustment for which it is preparing her. There is not much consolation in saying that her learning constitutes an adjustment to the school requirement.

More than any other animal, man must depend upon learning to make adjustments to his environment. But man's environment is so complex that an adjustment to one feature of it is not necessarily adequate for other situations or for life as a whole. As teachers we must have a broad view of the child's needs and endeavor to promote learning that will enable him to adjust harmoniously to all conditions of life.

Learning by doing. It has been observed that the modifications in a person's functional tendencies are brought about through activity. Without activity no learning takes place. This is a fact of prime importance to teachers. Some teachers have been impressed by the slogan "Learn by doing." This in itself is good. All learning is accomplished only by doing something. However, *doing,* it should be remembered, applies to all of the psychological functions. Some educators seem to imply that "doing" means only activity of the manual type, and have emphasized activities with the hands in constructive projects. Without intending to detract from the educative value of manual activity, the writer wishes to emphasize the point that the principle of "learning by doing" applies not merely to these but also to such activities as perceiving, imagining, comprehending, and creative thinking.

Does all activity result in learning? This is not an easy question to answer in the light of definitely observed facts. Of course we can say that activity results in learning only when it serves to modify subsequent activity. This is in keeping with what we mean by learning. But to say that any activity does not affect later activity is a different matter. Presumably the reflex activities, such as heartbeats, digestive processes, and breathing, occur over and over again without producing a change in these functions. The contraction of the pupil of the eye, as it ordinarily occurs, probably does not change the character of this response. Under special conditions, however, even these automatic responses are modified. Reflexes can be conditioned, as we shall see later.

Presumably some habits reach such a degree of automatization that further repetition of the act makes no change. When this is the case, no learning results from the continued repetition.

Of direct concern to the teacher is the kind of learning that results from the activity he secures from his pupils. It is safe to assume that some kind of learning is taking place as a result of the performance of school work. To be successful, from the teacher's point of view, classroom activity must result, in keeping with his objectives, in changes in behavior.

Connectionism. The concept of association has had a long history and an important influence in psychology. Aristotle formulated certain laws of association and distinguished association by similarity, by contrast, and by contiguity. The English psychologists of the eighteenth and early nineteenth centuries regarded association as the key to the secrets of the mental life. They used it to explain memory, perception, and reasoning. According to this doctrine, when mental processes occur together, they become linked so that if at some later time one of them is aroused, it in turn tends to arouse the others. If, for example, a person sees a boy standing on a bridge, the mental processes meaning boy and bridge become associated so that later sight of the boy calls up the idea of the bridge; or if someone in conversation mentions this particular bridge, the person in whom this association is established is inclined to think of the boy. The sequence of ideas was believed to be governed by the associations formed by previous experiences. The "qualities" from which these associations arise, according to Hume (1711–1776), were three: first, resemblance; second, contiguity in time or place; and third, cause and effect (9).

Experimental psychologists of the late nineteenth century found this doctrine of association of ideas unsatisfactory. They rejected the notion that ideas are discrete mental entities with a mysterious link binding them together and causing them to be recalled together. The qualities of resemblance, contiguity, and cause and effect were observed to belong to the objects of thought rather than to the mental processes themselves. The belief in a link between the ideas themselves was supplanted by the belief that the sequence of mental events, when not determined by external factors, was due to associative tendencies established in the nervous system as a result of previous activity. A new form of associationism appeared in the *stimulus-response psychology.* According to this psychology human activity was based on associations between stimuli and responses.

Educational psychology has been greatly influenced by the associative bond concept, particularly the stimulus-response variety. The psychology of learning built around this concept is known as *connectionism.* Its chief exponent is Thorndike. The connectionist sees in any unit of activity or *function:* first, a *situation* which influences or affects the individual; second, a *response* which the individual makes to the situation; and third, a *connection* between the situation and the response by means of which the former is enabled to produce the latter (20). This connection has been called the *S–R bond.* The term signifies a tendency or predisposition to respond in a particular manner to a given stimulus. In terms of observed behavior it refers to a degree of probability that a certain kind of response will be made under certain stimulating conditions. The bond is said to be strong when this probability is great, and weak when the probability is small.

According to the connectionist's point of view, knowledge, behavior, and personality are systems of bonds, each S–R connection being a unit part of the total. Learning is regarded as a process of building new bonds and organizing them into these systems. It has been described by the connectionist as a process of making connections (18, 21*a*). A child learns the name of an object by connecting the name with the object, or, more precisely, with his perception or thought of the object. Manual skills are acquired by connecting movements with appropriate stimuli. When the responses are in the form of movements, the connections are called *motor bonds.* Complex skills are believed to involve a great many motor bonds. Knowledge is acquired by building bonds between ideas. These are called *ideational bonds.* Memorizing is a process of building a fixed sequence of responses by means of a series of bonds.

This conception of learning as a process of building S–R bonds has lost favor in recent years. As an explanation of learning, it involves a point of view common to associationism and behaviorism, namely, that wholes are developed by compounding parts. According to connectionism, learning is a process of putting together units to form total experiences and complex forms of behavior. The modern approach, however, largely reverses the process. It sees the total experience or the whole function of the organism as the starting point of development. The newer trend is to regard learning as a process in which total functions are altered and rearranged in various ways to make them serve more effectively the needs of the organism. It is recognized that integration takes place, and that parts, particularly in the case of complex performances, are often put together in the course of learning. But the parts are seen as progressive steps leading to the final goal of the total performance.

Moreover, while the connectionist has recognized the fact that motives and other conditions within the individual play a part in determining the responses made to external conditions, the concept of the S–R bond has often been naïvely interpreted as a link between an external stimulus and a particular response through which the behavior of the organism is dictated almost entirely by environmental factors. Contrary to this notion, it appears reasonably certain that there is no fixed bond or functional relation between a particular stimulus and a particular response, by means of which that stimulus can invariably and under all conditions produce that particular response. To speak of a response to a stimulus is to identify part of the factors involved in the individual's activity. It may be justified at times as a matter of economy in description when the other factors are understood or implied. It must, however, be remembered that the individual's activity is not simply a response set off by an external agent; that it is determined not by a single stimulus, but by the whole pattern of stimulating factors, various sets and predispositions within the individual at the time, and the relations between the individual and the external situation.

The lack of a fixed control by a particular stimulus over a response to which it is connected was demonstrated experimentally by Köhler. He arranged two visual stimuli, B and C, with B lighter than C. Food could be taken from B but not from C. The spatial arrangement was varied. He used fowls and chimpanzees as subjects. After training had been continued for a time, the animals learned to react positively to B and negatively to C. Then in the place of stimulus C, another one, A, was substituted, which was lighter than B. It was found that the animals thereupon responded in the majority of cases, not to B, but to the lighter A. The response was not tied directly to B. It was made to the lighter of the two stimuli presented even where training would seem to have tied it to B (12).

Other experiments have indicated that when an interval patterning of a group of stimuli remains constant, as in melodies, rhythms, and mazes, one learns to respond to the pattern, even though the individual components may be changed (15).

Common observation shows that the operation of the strongest habit depends not alone on a direct bond between the stimulus object and the customary behavior. The habitual smoker is restrained in church or in the presence of superiors who disapprove of smoking. The opening of the elevator door may be a signal for leaving the elevator, but to get off at the right floor one must respond not alone to the opening of the door. The number of the floor will be quite as important a factor, and this in turn depends on the individual's goal. Thus, the initiation and control of any unit of behavior depend upon the total configuration of pertinent factors both within the individual and in the situation which confronts him. This is recognized and admitted by the connectionist, and to account for it he states that what roughly is called a connection is often in reality a bundle or system of connections (21*b*).

Definition of learning. The foregoing considerations concerning the general nature of the learning process lead us to the following generalization: *Learning is the development and modification of the tendencies that govern the psychological functions.*

With respect to learning, two things are directly observable: first, the activity through which learning takes place; and second, the results of that activity in the form of a change in the learner's performance. The results, however, indicate an antecedent change in the controls of the activity, and this modification of the controls of activity, or psychological functions, is the essential quality of learning. We refer here to the controls of functioning possessed by the individual, not to the governing agents afforded by his environment. The word *tendencies* is used to refer to factors of control that are within the individual. These controls, together with those supplied by the external situation, determine the nature of the individual's activities. They concern the initiation of the various functions and their regulation as they run their course. They appear in the form of sets, predispositions, motives, attitudes, habits, and functional trends.

These controls of activity are not observable in the same way that we observe the activity that produces learning and the changes in performance that result from it. To the learner himself, they may appear as desire or intent and be indicated in certain psychological moments of the complex performance. They may be reflected in flashes of perception, memory, imagination, comprehension, or searching that signify to the learner that he is moving toward his goal, that he is now off his course, that he must try another attack, and so on. Upon repetition, however, these psychological indicators of functional guidance tend to lapse, and the functional event is sometimes carried through under the direction of physiological functions without aid of psychological determinants (16).

When that stage in learning is reached where there are for the learner no psychological indicators of the control of his activity, or in cases where we are observing learning in another person, these controls are not directly observable. What we do observe is that under certain stimulating conditions a given form of activity takes place. But the individual's activity is governed only in part by the objects and energies supplied by the environment. The individual's own nature and condition are always co-determinants of the character of his reactions to these external conditions. Therefore, observed changes in the form of activity or in the manner of functioning under given external conditions indicate a change in the individual's functional tendencies. Learning is the process by which changes are made in the functional tendencies, and such changes can be regarded as learned only when they result from the individual's own activity.

Kinds of learning. We have seen that the psychological functions present both variety and complications. It follows naturally that learning, through which these functions are modified, may appear in many different forms. For purposes of our discussion, we may roughly distinguish seven major forms of human learning. This grouping, based on differences in learning outcomes, is chosen because the distinctions are somewhat traditional and therefore follow the lines of experimental research, and also because it seems suited to the needs of the student of education, since these are the main types of learning fostered in our schools. The seven forms selected are:

1. The development of motor skills and the habituation of action.
2. The development of perception and the improvement of observation.
3. Memorizing; the development of associative trends involving the learning of ideas or verbal responses in a fixed sequence.
4. The development of understanding through observation, listening, reading, abstracting, analyzing, and generalizing.
5. The development of the ability to solve problems by thinking.
6. Modification of the emotional reactions.
7. The development of attitudes and ideals.

Types of Functional Modification

As learning takes place various sorts of changes appear both with respect to the stimuli to which the individual reacts and with respect to the manner of reacting to the situation. Bentley has distinguished and defined five types of modification which he names: first, inclusion; second, substitution; third, ligation; fourth, elimination; and fifth, stabilization (1*b*).

1. Modification by inclusion. Functions are modified by way of inclusion when some new feature is incorporated into one's activity. The incorporation of new stimulus factors into the situation constitutes a change in the initial phase of the function, for it means that the individual has acquired new sensitivity to them, and his activity is altered to the extent to which it is affected by them. Such inclusions increase the skill of action, the keenness of perception, the fullness of understanding, and the soundness of judgment. An example is the case of the motorist who through experience becomes sensitive to the sound of his motor as a cue to accelerate in time to avoid stalling. Also, the ping-pong player incorporates into his performance attention to the sound of the impact of the ball on the table or opponent's racket, and the tennis player learns to watch the preparatory movements of his opponent.

In the subsequent or efferent phases of the function we have inclusions that mark a change in the individual's manner of dealing with the situation. Having burned his hand by grasping a hot pan, the camper thereafter uses a holder to remove hot dishes from the fire. The student who breaks a thistle tube in the chemistry laboratory becomes more cautious in handling his apparatus. A feeling of guilt becomes a new feature of an act for which one has been reprimanded. Perceptions are enriched as new elements are inserted from the expanding range of experience. One learns to see the ice as cold, the rain as wet, and the apple as an edible fruit of distinctive flavor. The student discovers on second reading a point missed during the first. Understanding is broadened by new experiences, and reasoning improves as we adopt more orderly methods of gathering and weighing evidence.

2. Modification by substitution. Sometimes the new element included takes the place of an original factor as an essential ingredient of the operation. Then we have a *substitution.* A more remote stimulus may be substituted for those originally serving to initiate the function, for instance, when the driver learns to increase his speed *before* he reaches the foot of the hill, or the class begins to put books and papers away preparatory to leaving *before* the dismissal bell rings. Elements in the situation which had at the first case of response no part in initiating the activity may become by substitution potent stimuli sufficient to produce the reaction even in the absence of the factors that were essential in the early stages. If a bell is rung every time a cat is fed, the bell soon becomes a call to food. The hungry cat will run to the feeding compartment when the bell rings even though no food is visible.

Substitutions take place also in other phases of the function. The child changes his mode of addressing his teacher from "Teacher" to "Miss Smith" when he discovers that she prefers the latter form. The golfer improves his score by adopting a new way of grasping his club. The adolescent finds it socially more advantageous to express his anger in verbal epithets than in childish screaming, biting, scratching, and kicking. Substitution of remote cues for immediate ones or of more adequate forms of response for relatively poor ones is frequently the key to the improvement of function.

3. **Modification by elimination and reduction.** The smoothing out and speeding up of a performance takes place to a large extent through the elimination of factors present at the start. Under repetition of a function errors, false motions, awkward methods, useless responses to distractions, and disturbing emotional reactions tend to drop out. Muscular tension, facetious or apologetic remarks, giggling, attention to irrelevant items are usually reduced as learning proceeds.

A conspicuous feature of learning is the reduction of the stimulus-pattern that initiates a function. The experienced motorist at night perceives an automobile approaching, even though all that meets his eyes is two bright lights gradually getting larger and farther apart. The *E* on the gasoline gauge means *empty* to him as definitely as could the whole five letters of the word. A number on a post by the side of the road tells him which way to turn. Tracks in the snow indicate to the hunter that a deer has crossed his path recently. A friend out of sight is recognized by his voice. A single scientific term may sum up years of research. In all these cases, and countless others that might be cited, it is evident that at some earlier time the individual would have found these slender cues insufficient for the responses they now elicit. A fragment of the one-time necessary set of stimulus conditions now serves perfectly well to set off the same, or similar, function.

This reduction of the stimulus-pattern in learning is in no way a violation of the principle that the individual's activity at any given moment is governed by the total situation. It means that the present whole situation lacks certain components that were essential to the activity before learning had taken place. The reduced cues mentioned in our illustrations were not the only factors determining the response. The *E* meant "empty" because it was on the gasoline gauge of an automobile. In some other setting it might have a wholly different meaning or arouse an entirely different response. As a mark on a pupil's examination paper, it could mean "excellent," or "not passed," according to the marking scheme used. The lights meant "automobile approaching" because they were seen on a highway. The tracks in the snow meant "deer" because of the particular circumstances accompanying them. The same is true of the other examples.

As an illustration of the manner in which cue-reduction operates we present the actual case of a customer who entered a tobacco store to buy some cigarettes. As soon as the man behind the counter saw the customer, he reached for two packs of a particular brand of cigarettes and handed them to the purchaser. Not a word was spoken by either man. The sight of the customer was a sufficient cue for the clerk's reaction because this customer had on several previous occasions regularly purchased two packs at a time of this particular brand. The spoken order, necessary at first, was no longer essential. But the present total situation was still the source of the clerk's behavior. Had he seen his customer on the street or in a railway station, this particular performance would not have occurred. The sight of the customer in that total situation served to set off the clerk's response, but from the total situation the originally essential spoken order had been eliminated as a result of learning.

In some of our discussions it will be possible to assume, or take for granted, the total situational setting. While not forgetting its importance, we may, as a matter of convenience, speak of the dominant factor, or the cue, which immediately sets off the function in question as the *stimulus*. In this sense, it can be said that the sight of the customer in our illustration above was the stimulus that elicited the clerk's response. The case is analogous to starting the engine of an automobile. Before the engine will start, a whole pattern of conditions must be in order. The gas must be available to the cylinders; the carburetor and other mechanisms must be properly adjusted; there must be electrical energy in readiness; and the ignition switch must be turned on. Stepping on the starter button alone does not start the engine. But with all the other requirements met, the push on the starter button is followed by a whirl of the motor and its pickup on its own power. It is the immediate condition to which the engine responds. It is, so to speak, the "stimulus" for starting the engine.

Besides the elimination of unnecessary movements and the reduction of the stimulus-pattern, in the development of motor skills the conscious intent or purpose for each unit of the performance, essential at first, drops out under continued practice. Perception also develops along the line of reduced cues. In the development of concepts there takes place the elimination of irrelevant concomitants of the essential elements. A child's concept of *river,* for example, is improved as he eliminates from it notions of particular location, direction of flow, width, and navigability. So it is with all the various functions. As one learns, there is a reduction of the total stimulus-pattern necessary to initiate and sustain the performance or to enable one to reach his goal, and there is an elimination of superfluous activity and futile responses (7, 8).

4. **Modification by ligation and integration.** Through repetition a function becomes more compactly *integrated.* The movements involved in shifting gears when starting a car, at first separate and consciously determined, become ligated, as a result of practice, into a new and unified series. The finger movements of the typist or piano player become incorporated through practice into a smooth-running pattern. Through repetition the recital of the poem becomes a temporally integrated performance. As the rat masters the maze, the runs and turns along the shortest and most direct path follow one another in swift and uninterrupted sequence. Through learning behavior becomes more perfectly organized. The disunity of unpracticed activity is transformed into unity of performance.

5. **Modification by stabilization and fixation.** The function under the changes described above is molded into a smooth-running performance of definite form, and then as continued exercise or renewal occurs, it becomes fixed, stabilized, and stereotyped. Through practice we pass to habituation and automatization. The action becomes fixed into an automatic form of behavior that is dependable and that will run itself through in a fixed sequence without conscious guidance. This is an operational economy for the organism, for by this means it can accumulate vast resources from its functional history that can be depended upon to serve it without being watched. This frees the organism to take care of the many other demands that require attention and intelligent consideration. Thus, the driver shifts his gears automatically in an efficient and orderly sequence while watching the course of traffic. The typist's fingers tap nimbly on the correct keys while she reads the copy. The boatman rows on sedately while meditating on the beauties of nature. The salesclerk mechanically wraps her bundles after the fashion set by habit as she describes to the girl at the next counter the movie she saw the night before.

Other types of functioning also become stabilized by repetition. Perceptions become fixed. Familiar scenes are the same to us under varying conditions. The boss is the boss wherever seen. Imagination tends to follow established patterns. We develop stereotyped conceptions regarding races, ministers, lawyers, doctors, and teachers. We adopt formulas which we regularly follow in writing letters, reporting research, or solving problems. Repeated recall of a past experience fixes it in a never-to-be-forgotten manner, though the fixed impression may have drifted considerably from the original perception which it represents.

The fixation of memorized material through memory drills is an important feature of classroom learning. The child must not only learn the combinations in arithmetic, the sequence of letters in spelling, dates and names in history, but these must be repeated through drills and review so that the functional tendencies involved will be fixed firmly enough to survive long periods of time and to insure accurate recall or recital whenever the occasion demands.

We have considered five forms of change in the psychological functions that take place through repeated renewals of the functions. They are the direct results of learning. They vary somewhat in different forms of learning. They take place more or less concurrently, except that fixation generally comes after the others. An essential point to which their consideration leads us is that the initial performance is not simply stamped in by repetition, but that it undergoes a process of alteration and refinement wherein new factors are incorporated, some factors are discarded, and the elements selected as appropriate are more closely integrated. Through this process the initial crude, awkward, hesitating, inefficient action is molded into a skillful performance; reading of a series of lines is transformed into recital; observation becomes more reliable; new imaginal and memorial references enrich comprehension; the meanings of many experiences become consolidated into concepts; deliberation and choice lapse into habit; and problems are attacked with greater fortitude and resourcefulness (16).

Learning and Organized Education

Schools are established and maintained for the purpose of securing desired learning outcomes. In a general way, it may be said that organized education seeks to perpetuate the good features of our social order, to secure the continuance of our social institutions, and to combat the evils that threaten them. Along with this we seek through education to secure and safeguard the individual's welfare and security in a complex society. These ultimate objectives can be achieved only by securing appropriate forms of functioning in the individual members of the social group. This requires that we clearly envisage our educational goals in terms of individual learning outcomes. Our success in accomplishing the purposes of organized education depends primarily upon the learning that takes place in the classroom under the direction of the teacher.

Educational objectives in terms of learning outcomes. It is possible to forecast certain types of situations that the individual is likely to encounter. We know with some degree of assurance what kinds of abilities and what forms of behavior will serve the individual to advantage in these situations and at the same time be socially acceptable or desirable. These include certain *skills,* such as writing, reading, and arithmetical computations; certain *habits* of personal hygiene, emotional stability, and social behavior; and a variety of verbal responses. They represent forms of functioning which we are quite certain will be useful or necessary. Since we can foresee the need for them, it becomes our task to mold and fix these functions so that they will be ready when the occasion demands.

It is apparent, however, that we cannot foresee all the situations a child will be called upon to face in his later life. We cannot supply him with ready-made modes of functioning in the form of habits, skills, and memorized materials that will serve all his future needs. Unpredictable demands and questions are certain to arise. He must therefore be equipped with *knowledge, understanding,* and some *training* in the *art of problem solving* so that he can devise for himself appropriate answers and suitable modes of behavior.

It is also essential that the individual be disposed in a general way so to conduct himself that his own well-being and the interests of his associates will be safeguarded and preserved. It is important that his conduct conform to the ethical standards of society. Therefore, certain general functional trends are to be established that will assure desired features of conduct in even widely differing circumstances and in varied types of activity. *Attitudes* and *ideals* are the learning outcomes that meet this need.

These three types of learning outcomes: first, skills and habits; second, knowledge and understanding; and third, attitudes and ideals, are the educational objectives toward which the work of the teacher is directed.

School activities that lead to desired learning outcomes. The fact that learning takes place only through activity means that the first concern of the teacher is to secure activity on the part of his pupils. To be a successful teacher he must know what the desired outcomes are, and then secure those forms of activity which will develop his pupils' functions in the direction of these goals.

The activities that the teacher directs in the classroom are instances of the initial or repeated exercise of the functions which undergo modification and fixation. They may be described in terms of the psychological forms of functioning; namely, acting, perceiving, emotion, remembering, imagining, comprehending, and thinking out the solutions of problems. However, since these modes of functioning are frequently combined and intermingled in the usual classroom forms of learning, we shall, in the interests of economy and clarity, refer to the activities through which the individual learns as *learning activities*. Thus, any exercise or renewal of a function that produces learning is a learning activity.

To secure a desired learning outcome, the teacher must devise exercises the doing of which will involve appropriate learning activity. These exercises must not only be appropriate to develop the desired skills, understanding, and attitudes, but they must also be suited to the child's level of ability. The problem of motivation enters here, for in addition to planning work for the pupils the teacher must assign the exercises and stimulate the children to do them. Then there is also the problem of guiding and directing the learning activity. These problems will be discussed in later chapters.

The following examples illustrate the place of learning activities in classroom learning. The child develops his ability to use his hands with greater skill by making things, by drawing, and by painting. His manipulation of tools and instruments is improved through imitation and practice. He learns to write by writing, to sing by singing, to coöperate with others by engaging in coöperative activities, such as projects or dramatics. Memory drills mold the functions toward fixed or verbatim recital and ready verbal responses. The learner acquires facility in expressing himself by reciting, telling stories, and writing themes. He acquires knowledge and develops his understanding by reading, studying, looking at pictures, examining specimens, making collections, listening to talks and lectures, debating, discussing topics, solving problems, going on field trips, and performing laboratory experiments. Attitudes and ideals are developed by imitation and as incidental products of the activities already mentioned. Here the child's reactions to social situations and social relations are of particular importance. He restrains his overt emotional reactions as he apprehends the social consequences of his emotional outbursts. These are some of the well-known forms of activity through which learning takes place under the direction of the teacher.

Training and experience. We commonly speak of learning through "experience." However, *experience,* as used in this sense, always involves some activity on the part of the experiencer. This experiencing activity is, therefore, learning activity. It may appear as any one or a combination of the various modes of psychological functioning. To speak of "learning by experience" implies a change in mode of behavior or in our ways of thinking as a consequence of experience, but it does not imply the prearranged types of experience or activity for purposes of preconceived effects.

Training, on the other hand, does imply arrangement of learning activities and direction, usually by another person, of the activities, so that preconceived outcomes of learning may be attained. Under training the learner is told what to do, and how to do it. His errors are checked and his practice is supervised. Training provides selected experiences for learning. A good instructor takes many of the hazards out of learning and reduces the waste of time and energy. The child will learn from experience without the aid of the school. It is the business of the school to provide training.

Learning may be intentional or unintentional. In the previous chapter it was pointed out that learning is not a distinct form of functioning. Any mode of psychological activity or combinations of such modes may serve to alter the functions. The most that we can say for the uniqueness of learning activity is that in many cases it involves the purpose to learn. The child reads and rereads the tables of weights and measures in order to be able to recite them. The student reviews his lecture notes so that he can answer the questions on the coming examination. The golfer practices his driving in order to improve his score. Learning is intentional when the learner practices to improve his skill, when he studies to increase his knowledge, or when he engages in any activity with the definite purpose of improving his abilities or of acquiring new ones.

But learning also takes place through experiences or activities when there is not the slightest thought of future performances. It may and often does occur when there is not only no intention to learn, but also when there is no realization that it is taking place. As this paragraph is being written, some boys are playing with a football in a vacant lot nearby. They appear to be having a good time kicking and catching the ball. They are apparently playing for the enjoyment they get from their running, kicking, catching, and tackling. They apparently are not trying to develop anything in particular. Their activity is quite different from the expertly coached maneuvers of the varsity squad on the eve of an important football game. Yet in their play these boys are undoubtedly developing coördinations that will improve their kicking, catching, and dodging.

The learning of infants is not intentional. The child's behavior patterns take form under the influence of his reactions to the stimulating conditions of his physical and social environments. He learns rapidly and effectively without purposing to learn.

In school some learning is premeditated, but there is also much that is incidental. In most cases of school learning it will be advantageous to secure a desire for improvement, and hence purposive learning activity.

THE BODILY BASES OF LEARNING

All learning depends upon bodily structures and their integrated functioning. There are, however, no special organs or structures of the body for acquisition of skills and knowledge. The receptors, the muscles, the glands, and the nervous system constitute the somatic bases of learning.

Receptors. The environment presents certain forms of energy called *stimuli* which impinge on the organism. These, acting as irritants, disturb the equilibrium of the organism, and initiate activity through the neuromuscular system. But a stimulus can initiate activity only if the organism is sensitive to it. Certain structures of the body are highly sensitive to particular forms of energy. They render the specialized service of receiving physical stimuli, and for this reason are known as *receptors.*

There is considerable specialization among the receptors themselves. Each is sensitive to at least one kind of energy but not to all. The eye contains cells which are receptors sensitive to light energy. In the inner ear are receptors which are aroused by air vibrations. In the nose are sense cells which are stimulated by gases and volatile particles. In the skin are the receptor cells for heat, cold, pressure, and pain. Because they receive stimuli from outside the body, these receptors are called *exteroceptors.*

Inside the body there are many receptors which receive internal stimuli. On the tongue are receptors sensitive to chemical substances in solution. Others are found in the throat, intestines, stomach, and lungs. These are called *interoceptors.* Those located in the muscles, tendons, and joints, and stimulated through movements of these parts are the *proprioceptors.*

Man is dependent upon this receiving set for his contacts with the world about him. It determines and limits his range of response. If some of the receptors are defective or missing, as in the case of the blind or deaf, the range of functional contact with one's environment is correspondingly diminished. Without the visual receptors we would have no world of sight or colors. Without them nothing could be learned about the appearance of objects, and none of the many skills for which sight is essential could be developed. Likewise deficiencies in the other organs of sense handicap or preclude certain kinds of learning.

The receptors condition the various forms of sensory experiences; sensory experience is essential to perception; and perception is the basis for memory, imagination, and thinking. Thus, our knowledge rests directly or indirectly upon impressions received by way of our receptors. Our skills and habits could not be maintained or even developed without the services of these receiving mechanisms.

Effectors. In all animal life, movement is a vital factor in adjustment and survival. The bodily mechanisms for movements are the muscles. The contractions of the skeletal muscles execute the voluntary movements and certain reflex responses. The smooth muscles of the internal organs take care of involuntary movements of these organs. The muscles are called *effectors.*

There is probably no learning activity that does not involve the muscles, for the action of muscles is an integral feature of the psychological activities. The role of these effectors in the case of the action and the motor skills resulting from the repeated renewal of actional functions are matters of common observation. But the muscles also play an important, though less universally recognized, part in perceiving, remembering, imagining, comprehending, and thinking. In visual perception, for example, we have eye movement and convergence, and accommodation of the lens. These not only provide for a clear stimulus-pattern on the receptor cells in the retina, but they make a significant contribution to our awareness of the distance of the apprehended object. The muscles of the vocal cords not only give us speech, but they also play an active role in the thought processes (13). Through learning, the muscular system is trained to serve the organism effectively by precise and delicately patterned movements.

The nervous system. The receptors and muscles play their parts only in connection with the nervous system. This somatic system links together all the organs and structures of the body into a working unit. Nerves connect the receptors and muscles with the central nervous system, which consists of the spinal cord and the brain. The brain has been called the "great central adjuster" because the integration and smooth performance of the psychological functions depend upon its services.

It is commonly assumed that the functional modification that takes place through learning is due to some kind of change in neural structure and that this change is effected by the nervous system's own operations. These operations are the neural processes involved in carrying on the learning activity. It is supposed that they leave their mark in the form of structural changes in the great central adjuster, and that these changes determine the altered character of the functions when they are renewed. What the nature of these changes is, nobody seems to know. The microscope reveals no difference in the appearance of the brain cells before and after learning has taken place. The evidence in favor of the view is found chiefly in the loss of the effects of learning through damage to brain tissue, and deductions from the generally accepted principle that the central nervous system governs the functional effects of stimulation.

Glands. Mention should be made of the glands, though their connection with learning is probably less direct than that of the neuromuscular system. The glands are classed with the muscles as *effectors.* Their activity is governed by the autonomic nervous system. Under stimulation they secrete certain fluids that stimulate and sustain the vital processes of the body. The secretions of the *duct glands* pass through little tubes, or ducts, and are discharged into internal chambers of the body, such as the mouth or stomach, or on the outer surface of the body. Examples of duct glands are the sweat glands, which help to maintain uniformity of bodily temperature, and the salivary glands, which assist in the digestive processes.

The *endocrine,* or *ductless, glands* make up an intricate and integrated system of regulators of the bodily functions. Under stimulation they secrete powerful hormones which are discharged directly into the blood stream. These hormones promote growth, physical vigor, energetic action, and mental alertness. Because the normal action of the glands is essential to the full effectiveness of the psychological functions, glandular dysfunction or imbalance may produce states highly detrimental to learning.

Energy. Any activity requires and uses energy. This is as true for the so-called "mental activities" as for physical activity. The body furnishes the energy as well as the mechanism for the learning activities. Serious loss of physical energy means a loss in the ability to learn.

For a more complete description of the bodily mechanisms of action and reaction and how they operate in support of the psychological functions, the reader is referred to chapters on the nervous system and sense organs in textbooks on general psychology or physiology (1*c*, 2, 3, 6*b*, 14, 17, 19, 22, 23, 24). The aim of this short section on the bodily bases of learning has been to emphasize the fact that learning is dependent upon the normal functioning of the somatic systems. The process of developing and stabilizing the functional trends is a psychological process, an essential and integral part of which are the physiological processes of the receptors, muscles, and nervous system. This means that an intact and healthy body is essential for the best results in learning. Physical defects, fatigue, and bodily malfunctioning are handicaps to learning to such an extent that a later chapter will be devoted to them.

Explanation and description. The task of science is to describe and to explain the phenomena it investigates. Scientific description is based on careful and systematic observations. It is the result of an effort to give an accurate, impersonal, and unbiased statement of all the facts that can be obtained. In explanation an attempt is made to tell why an event occurs or why an object manifests particular characteristics. Scientific explanation is made in terms of conditions or events that have been found to accompany or precede the phenomenon under consideration. Learning is described in terms of the changes in performance. It is explained in terms of conditions antecedent to or accompanying these changes.

Many of these conditions are known because they can be observed directly. The known conditions include the factors of the external situation, certain conditions of the learner, and methods of procedure with respect to the learning activity. Being more or less amenable to control, these conditions have been studied experimentally and correlated with observed results of learning. They do not supply the whole explanation of learning, for there remains the question of why and how these observed conditions produce the changes in the learner's behavior. The answer to this question lies beyond the range of observation, and it can be given only in the form of an explanatory hypothesis.

In the preceding section reference was made to the *assumption* that a function leaves a "trace" in the form of a change in the nervous tissue and that this trace is responsible for the altered form of the function on its subsequent appearance. Many theories have attempted to explain learning by stating what may be the nature of the neural change responsible for functional modification (4, 10, 11, 14). It should be understood, however, that any explanation of learning in terms of connections between neurones, synaptic resistance, or other neurological structures and functions is hypothetical.

Whatever may be the nature of the neural conditions of learning, the teacher does not produce them directly. They result from the learner's activity. Even if they were clearly known, the teacher would still have to depend on learning activity to secure the desired learning outcomes. In the chapters that follow we shall be concerned chiefly with the observed and known conditions of learning, particularly with those that concern the effectiveness of learning activity. These are the conditions that we may hope to manage in fostering learning and are, therefore, of most practical concern to the teacher. The next six chapters are devoted to six fundamental principles of learning. These principles are generalizations concerning conditions under which learning takes place.

SUMMARY OF THE CHAPTER

Illustrative cases of learning were presented to show that when one is learning, he is engaged in activity by which he acquires the ability to do something he could not do before, or as a result of which he tends to do certain things differently.

Through modifying the individual's functional tendencies, learning brings about alterations in the psychological functions. In general, this change may be described as improvement of performance.

Connectionism is a point of view which regards learning as a process of building or strengthening connections between stimuli and responses by which the former are able to produce the latter. The concept of a fixed *S–R relationship* is unsatisfactory, since an individual's behavior at a given moment depends, not alone upon a particular stimulus, but upon the total complex pattern of factors which includes the conditions within the individual, the external stimulating agents, and the various relations between the individual and the constituents of the external situation.

Learning may be defined broadly as the development or modification of functional tendencies through activity.

The following seven forms of learning have been selected for consideration: sensorimotor, perceptive, memorizing, the development of understanding, the development of ability to think out the solutions of problems, modification of emotional activity, and the development of attitudes and ideals.

Changes in performance resulting from learning include: the incorporation of new elements, substitutions of new factors for old ones, the elimination of many features present at the start, the closer integration of the surviving elements, and finally the fixation of the function in its modified form.

Schools are conducted for the purpose of securing certain learning outcomes. Educational objectives stated in terms of learning outcomes are skills and habits, knowledge and understanding, and attitudes and ideals. The teacher's task is to develop these. To do so he must secure appropriate learning activity on the part of his pupils.

Learning is sometimes, though not always, intentional. Much learning, in school and out, takes place incidentally. For securing improvement in school learning, definite goals with intent to learn are, as a rule, desirable.

The learning process involves in a very direct way bodily structures and organs. Receptors, glands, and the neuromuscular system constitute the somatic bases of learning.

Learning is described in terms of functional modification. It cannot be described in terms of neurones and synapses. It is explained in terms of conditions correlated with progressive modification of functions. Explanations are sometimes made in terms of supposed conditions or events in the central nervous systems. Such explanations are hypothetical. Of most concern to the one who seeks to promote learning in pupils are the known and manageable conditions of learning.

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PART II

SIX FUNDAMENTAL PRINCIPLES OF LEARNING

CHAPTER III

MATURATION AND LEARNING

The principle of maturation: *The ability to learn is limited by the degree of maturation attained at the time the learning situation is encountered.*

By *maturation* is meant the normal physical growth of the bodily mechanisms of the psychological functions. If these physiological structures have not developed to the point where the child can carry on the activity essential for a particular kind of learning, it is quite obvious that he will be unable to achieve success in this direction. Learning and maturation have much in common, and they are so intimately intertwined in infancy that it is often difficult or impossible to distinguish between them.

Experiments on animals. Experiments have been carried out on lower animals to show the influence of maturation on behavior. Carmichael (2) placed the larvae of salamanders in an anesthetizing medium. No movement was observable although the growth processes continued. After they had reached the age and size at which salamanders normally swim, these anesthetized animals were placed in fresh water. Here they swam naturally after a short time equal to that necessary for them to recover from the effects of the anesthetic. These results seem to indicate that prior activity, and hence learning, had little or nothing to do with the development of this swimming behavior, and that physical growth or maturation was mainly, if not entirely, responsible for it.

The pecking activity of newly-hatched chicks is far from efficient. They have trouble with their aim. Their seizure and swallowing of small particles of food is a clumsy and poorly coördinated performance. They improve rapidly, however, with practice. Experimental studies have been made to determine, if possible, the relative contributions of maturation and practice to this improvement. Shepard and Breed (15) found that chicks, prevented from pecking and force-fed from three to five days after hatching, improved with practice faster than chicks of a standard group that began pecking on the second day, so that within two days the performance of the delayed groups was as good as that of the standard group.

In a similar experiment but without force-feeding Bird (1) later obtained similar results. He used four groups which were kept in the dark to prevent pecking practice for different intervals of time. At the end of the interval of confinement the first test was given in which performance was scored by counting the number of successful seizures and swallows during a series of twenty-five trials. On the following day a second test was given, and this came at the age at which the following group was given its first test. The ages and scores for the four groups were as follows:

Group	*Average age at 1st test*	*Mean score 1st test*	*Mean sqore, 2nd test (after 1 practice period)*
I	9 hours	.65	2.91
II	30 hours	2.62	5.6
III	51 hours	3.58	5.0
IV	72 hours	4.63	4.63

The advantage of maturation is shown by the increase in the scores on the first test with the increase in age. The advantage of practice is shown by the fact that the second-test score for each of the first three groups was larger than the first-test score for the following group though obtained at the same age. These data indicate that, without practice, performance is better in the more mature chick, and that with equal maturation, practice makes for a better performance than no practice. The results show that both maturation and learning contribute to the development of feeding behavior in young chicks.

Cruze (3) compared the ability of young chicks, differing in age from twenty-four hours to three weeks, for learning to run mazes and solve problem boxes. He found that the ability to learn these performances increased directly with age. He believed there was a social factor as well as maturation which contributed to the superior ability of the older groups.

Human maturation. The human infant is a helpless creature at birth and is slower in gaining ability to manage himself adequately than young animals. This is not because animals learn faster than the child, but because the young animal matures at a more rapid rate and much of its behavior is instinctive. Behavior patterns are said to be *instinctive* when they are determined by maturation rather than by learning. There is comparatively little if any of this sort of behavior in human infants. They require a longer time to reach maturity, and learning plays a correspondingly greater part in the development of their behavior. At least the difference is great enough to prevent our attributing instincts or growth-determined behavior patterns to human beings simply on the ground that they are found in animals. So for further light on this problem we turn to the studies on human maturation.

Prenatal development. Since the baby can do many things when he is born, we must first consider prenatal development. Presumably this is mostly maturation. In the early stages growth takes place rapidly by an increase in the number of cells through cell division. In the later stages growth is accomplished almost entirely through enlargement of the cells. By the end of the first month the eye-cup has taken its initial form and the heart begins to function. By the fifth week the main parts of the central nervous system are outlined. Limb buds appear between the fourth and eighth weeks. By the eighth or tenth week the typical human form has been assumed and the general bodily structure laid down. From the tenth week to birth the body of the fetus increases many times in length. About the end of the second month the limb buds make slow movements. Then reflex movements appear, gradually being differentiated out of mass movement and becoming more specific. Crying occurs among infants born at six months. During the seventh month the structures are much the same as at full-term birth. During the eighth and ninth month there is a large amount of mass movement with further development of the specific character of the reflexes.

The question of prenatal learning. When the baby is born, his receptor-neuromuscular system is developed sufficiently to provide for a great many essential activities, such as breathing, feeding, crying, digestion, and elimination. He yawns, hiccoughs, sneezes, pulls his hand away from painful stimuli, grasps a small rod placed in his hand, and turns his big toe upward when the sole of his foot is stimulated. Besides these comparatively specific reflexes there is a great amount of mass activity in the form of wriggling, twisting, waving of arms, and kicking of legs.

It has been generally assumed that all this activity results from maturation alone; that the essential neuromuscular connections are formed in the process of growth, and not through learning. It has been taken for granted that there could be no opportunity for learning prior to birth; hence, that behavior at birth must be innate and unlearned. However, in recent years there has been a growing tendency to attribute the specific character of complex behavior patterns less to pure maturation determined by hereditary factors and more to environmental influences and learning. The concept of instincts as inherited, growth-determined patterns of behavior has been found wanting and has been abandoned in human psychology. Now the question arises whether the reflexes, those simple forms of reaction present at birth, may not have been differentiated from mass activity of the fetus by a process more properly regarded as learning than as maturation.

According to one view (11, 13) the movements occur first simply as part of the generalized mass activity of the fetus aroused by internal stimulation. If some form of external sensory stimulation occurs at the time of a movement, an association is made in the nervous system between this sensory stimulation and the processes producing the movement. Because of this association after the manner of learning known as *conditioning,* this sensory stimulation becomes adequate for the production of that particular movement. In this way, a new reflex is formed or differentiated from the mass reactions of the fetus. To illustrate, let us assume that as a part of the mass reaction the fist is clenched. This produces a pressure on the palm of the hand, causing a sensory stimulation at that point. According to this theory, pressure on the palm becomes, by conditioning, an adequate stimulus for producing the grasping response. If this version is correct, the grasping reflex and possibly many others are differentiated from the mass reaction and take on the specific character they manifest at birth through the reactions of the individual before birth, and hence are learned. Even if this represents an extreme swing too far from the old emphasis on hereditary determination of behavior, it is certainly a challenging point.

Postnatal maturation. In postnatal development maturation continues for fifteen to twenty years. During this time learning and maturation go on together. These two forms of development are so intermingled that it is not easy to distinguish their respective contributions. Yet it is desirable from the standpoint of education to do so as far as possible in order that we may judge the appropriate time to apply various forms of instruction and training most advantageously. For this reason we should consider some of the studies which have investigated the relation of maturation to learning in children.

In the first place we know by common observation that the newborn baby cannot learn to do such things as drive a car, play the piano, or walk, because of physical incapacity. His muscles are not strong enough, his limbs are not large enough, and probably his nervous centers are not sufficiently developed. With regard to the nervous connections, however, the case is not so clear. It may be that there are action systems ready to function at birth, so far as the nervous system is concerned, which are not manifest because of the sheer muscular weakness of the infant. This is suggested by the walking and crawling movements observed in young infants whose weight is supported.

The uniform sequence of motor development. In recent years a number of excellent studies of infant development have revealed a strikingly uniform order in the appearance of certain forms of behavior in the early months. Gesell, whose work in this field is outstanding, states that: "Patterns of behavior in all species tend to follow an orderly genetic sequence in their emergence" (6). From careful and extended observations on a large number of infants, Gesell has presented a normative schedule for the appearance of various motor traits in average children (5).

Shirley (16) has made a thorough study of the developmental sequence in twenty-five babies through the first two years. Postural and locomotor development was found to follow a fairly uniform pattern. At about the third or fourth week the average child holds up his chin when placed on his stomach. A little later, when lying in this position, he raises his chest. At about four months he sits with support, and by the seventh month he generally manages to sit alone. Next he stands with help or by holding on furniture. Then follow in order: creeping, walking when led, pulling up to standing position beside furniture, climbing stairs, and standing alone. Finally at about fifteen months he walks alone. Shirley found considerable variation with respect to the age at which the traits appeared in different children. But since the children were free to engage in as much activity as they desired, she felt these differences could not be accounted for on the basis of differences in practice. The uniformity in the sequence of motor development points significantly to a maturational factor. The effects of practice are manifest, but they do not account for the uniform order of development in these infants.

Significant in this connection is the case of a prematurely born baby described by Goodenough (8). This child, born two months before term, had to be fed artificially with a medicine dropper, because the sucking and swallowing reflexes were not developed. Placing the nipple in the child's mouth failed to elicit any sucking movements. At about the end of two weeks, however, the response appeared suddenly, and in twenty-four hours the natural feeding reactions were established so that artificial feeding was no longer necessary. As Goodenough points out, the sudden appearance of this reaction without previous practice is quite unlike the gradual modification seen in learning and is "what we might expect to occur if the behavior were dependent on the completion of the growth of some neural mechanism by which it is controlled."

Experiments on maturation and practice. A number of experiments have dealt more directly with the relation of the degree of maturation to the ability to learn. Gesell and Thompson (7) gave one of a pair of identical twins daily practice in climbing stairs for a period of six weeks. During this period the other twin was not trained in this activity. At the end of the six weeks, when the twins were fifty-two weeks old, the trained twin climbed the stairs in twenty-six seconds. At fifty-three weeks of age the twin who had not been trained climbed the stairs in forty-five seconds. But at the age of fifty-five weeks this twin, after two weeks training, climbed the stairs in ten seconds. The second twin did better at fifty-five weeks than the first did at fifty-two, even though the first one had been trained three times as long. These authors concluded that the superiority of the second twin was due to the fact that she was more mature at the time of training.

Hicks gave one of two equal groups of young children practice once a week for eight weeks in hitting a moving target. Then both groups were tested once a week for two weeks. The difference in improvement made by the two groups was too slight to be significant. He concluded that "for the development of complex motor skills in preschool children, maturation and a general environment in which many experiences are possible, are much more important than systematic practice" (9).

Jersild (12), using two equated groups of six- and seven-year-old children, gave one group thirty-one practice trials in color-naming distributed over a period exceeding three months. The children were presented a sheet containing one hundred colored squares. Five different colors were used and these were arranged in rows of ten each. Each child was asked to name the colors as rapidly as possible. The score was the time required for naming the one hundred colors. The score for the practice group at the end of the period of training was better than that of the control group which received no practice, but after three months had elapsed, when both groups were again tested, it appeared that the advantage of the practice group had disappeared.

This study included also a comparison with adults who were given training similar to that of the practice group of the children. The final score for the adults after training showed a gain of twenty-two per cent, while the final score for the children showed a gain of approximately twenty-four per cent. Thus, it appears that while the adults made better scores, in proportion to their initial performance the children and adults made practically the same gains. The results indicate that the improvement derived from training is definitely limited by the child's level of maturity.

Hilgard (10) gave a group of ten children, twenty-four to thirty-six months old, practice in buttoning, climbing, and cutting with scissors for a period of twelve weeks. A control group, equated for chronological age, mental age, sex, and initial abilities, was also tested in these skills at the end of this twelve-week period. The performances of the trained group were superior in all tests at the end of the practice period. But after one week of practice the performances of the control group were as good as those of the practice group after its twelve weeks of training. The fact that the control group gained more rapidly was believed to be due to factors of maturation and general practice in related activity.

Gates (4) conducted an experiment to determine the effect of practice on the immediate memory for digits. After practice spread over a period of five months, his practice group showed a gain of 2.07 digits while the gain of the control group was 0.73 digit. However, after four and one-half months, the scores of the two groups were practically identical. The superiority of the practice group was only temporary. There was soon a recession to the normal maturational level.

Both maturation and learning contribute to the development of ability. If we regard maturation as the normal growth of the physiological mechanism of function, it is to be noted that we are not warranted in ascribing the improvement of the non-practice groups in these and similar experiments on this problem entirely to maturation. The control groups, while deprived of specific practice on the particular function under observation in the experiments, were not anesthetized as were Carmichael's salamanders. They were presumably active about many things, having a variety of experiences, and probably exercising functions that could be easily transferred to the final test performances in such a way as to contribute to the improvement these groups showed. Insofar as this was the case, it must be admitted that learning combined with growth for this improvement of the non-practice groups. The improvement comes from learning if it is due to the exercise of the function. If it comes from the growth of muscles, bones, and nerves, it is due to maturation.

The learning of some forms of activity may be wholly impossible because of insufficient maturation. Such is the case where the child is physically incapable of performing the task. Thus, the child cannot learn to play ball nor walk alone at six months because his physical structure has not reached the stage of growth essential for those activities. If, on the other hand, the child fails to learn because his language comprehension is insufficient for him to understand what he is told to do, his failure may be due to a poverty of experience, and he may or may not be sufficiently mature for the task. Moreover, he may be mature enough to perform the task, and improve to some extent as a result of practice, but not be able to improve so rapidly or to reach so high a degree of skill as one who is more mature. Lack of sufficient maturation may restrict one's ability to learn without preventing it altogether. Likewise, lack of the appropriate experiences or training may also prevent or limit one's learning.

The question of mental maturation. The child's ability to perform certain tasks without specific training develops year after year until maturity is reached. His ability to learn and to solve problems increases. A child of two years is unresponsive to a problem situation which a four-year-old attacks and successfully overcomes. A child of three cannot copy a square with a pencil but by the time he is five years old he usually does so readily. At four years and six months he is normally able to repeat four digits after hearing them spoken, but he cannot repeat six. Yet at ten years, without training in digit memory, he repeats six after hearing them. Now this kind of development is commonly called *mental.* It is the sort of development we seek to appraise in our intelligence tests. Sometimes it is called *mental maturation.* The performance of these and all tasks used in intelligence tests depends upon former experiences and the previous exercise of functions. We will do better to speak of *mental development,* into which both learning and maturation enter, and use *maturation* when we wish to refer to the natural growth of the physical mechanisms of the "mental" functions. These physical mechanisms include the brain and its inner structures as well as muscles and bones.

The educational significance of maturation. It follows from the foregoing considerations that maturation, the natural growth of the somatic bases of learning, definitely conditions the ability to learn. If a child is so immature that he is unable physically to perform the learning task, then that learning is impossible at that time. Later on, as he grows, he may be able to accomplish the same task with ease.

If the learning task is not entirely beyond his reach but is too advanced for his level of growth, he may improve with great effort, or make slow, clumsy, and uncertain progress. In such a case his gain may be only temporary. If the task is wholly suited to the maturational level, we have met the first requirement for efficient and effective learning.

The problem of grade placement of various kinds of learning has to do with *learning readiness.* This involves maturation, previous experiences, practice, and interests. Too little is known about the maturational levels necessary for the most effective and efficient mastery of the elementary school subjects. It is exceedingly difficult to conduct scientific experiments in this field. We must depend on general observation, practical judgment, and our knowledge of the principle of maturational limitation of learning. In general, the more progressive current thought favors doing away with formal and difficult work in the lower grades in favor of activities that will enrich the experiences and understanding of the children. Much of that which is essential can be learned more quickly and with less arduous drill later, because of the greater maturity reached and because the wider range of experience makes the work more meaningful.

In the case of arithmetic it is felt that certain aspects of the subject have been taught too early. Wilson (17*a*) claims that when young children are forced into the mechanical phases of arithmetic, they waste time and develop errors that hinder their work later. The tendency in this subject is to simplify the course of study and to postpone the teaching of some operations until later years. For example, Wilson (17*a*) maintains that there should be no formal number work in the first two grades, and that the work of these grades should be devoted to experiences and activities which will develop the number concepts. It has been found that a large proportion of the errors in solving problems are due to the child's inability to understand the problem situations (14). It is suggested that long division be deferred until the fifth grade, in order that children may more fully understand the steps. It is held that this should result in better teaching of this process and eliminate the grind and meaninglessness of long division prevalent in earlier grades (17*b*). Perhaps it would be a good thing to defer all formal instruction in arithmetic to the later grades and the junior high school.

The instruction in formal grammar has been largely abandoned in the lower grades because young children are not ready to benefit by such instruction. The teaching of reading is frequently undertaken in the kindergarten. However, research and expert opinion indicate that for economical learning of reading a child should have attained a mental age of about six years and six months. This suggests that reading should be started not earlier than the second half of the first grade. Before this the time should be devoted to the experiences which will provide a comprehension background for reading.

Meaning and understanding referred to here, of course, are not simply matters of maturation. They come from learning, but this learning is also restricted by the degree of maturation and the lack of opportunity for appropriate experiences. We should see that it is unwise to try to force children beyond their depth. Our efforts will be futile in extreme cases, but in less serious cases of physical and mental limitations we may subject the child to wasteful effort and needlessly arduous drill in order to secure a gain which he could secure later much more quickly and more easily. Moreover, this crowding may even develop errors and deficiencies which will require great effort to eradicate later on. The placement of subject matter at appropriate maturational levels is important for economical and effective learning. This problem is made difficult by the wide range of intelligence, achievement, and maturation that is found in any one grade.

Summary of the Chapter

The term *maturation,* as used here, means physical growth. The ability to learn is limited by the degree of maturation attained at the time the learning situation is encountered. Experiments on animals have shown that learning ability increases with an increase in the degree of maturity. The period of maturation is longer in human beings than in lower animals. Rapid growth of bodily organs and the differentiation of many reflexes take place during the period of prenatal development. While the reflexes which appear at birth or soon after have usually been considered unlearned or growth-determined reactions, some writers hold that they result from the reactions of the fetus and therefore are developed by learning.

During the period of postnatal development, maturation and learning go on together. Studies of infants show that there is a high degree of uniformity in the sequence of motor development as it takes place in different children. This uniformity points to a maturational factor that regulates and restricts the acquisition of new forms of behavior.

Experiments on children have shown that improvement from training and practice is limited by the child's level of maturity, and that the ability and readiness to learn are dependent upon both maturation and the results of previous learning.

For the most effective learning in school, the learning tasks should be suited to the child's ability level. This calls for a careful consideration of the grade placement of curricular materials.

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Chapter IV

VARIED ACTIVITY AND TRIAL-AND-ERROR LEARNING

The principle of varied activity. *A large part of human and animal learning takes place by means of varied activity in problem situations.*

Mass-to-specific sequence. In the development of behavior we usually have varied activity at first, and from this varied activity specific forms of response are selected. A stimulus applied to the fetus in its early stages elicits movement of the whole organism. Leg movements and mouth movements occur along with gross body activities. Specific reflex responses emerge from the whole activity as development proceeds. This course of development is likewise found in postnatal development.

The child's activity at birth consists chiefly of mass movements with comparatively few coördinated specialized responses. After a few weeks, as the child tries to reach for a small toy, he moves not only his right arm, but his left arm, legs, head, mouth, and other parts. He literally wiggles all over in his attempt to get hold of the object. By doing many things, his hand finally hits the object and his fingers then close in on it. At the end of twelve months his reaching and grasping will have taken on a more definite form. The number and intensity of the useless and unnecessary movements will have decreased considerably. He makes a more direct approach to the object.

Something like this occurs when older children or adults are confronted with a new situation. There is likely to be manifold activity from which under repeated trials specialized reactions emerge through a process of individuation. In the initial stages of learning to write, the whole muscular system of the child is tense; he grasps the pencil too firmly, presses down too hard, sways his whole body, moves or purses his lip, protrudes his tongue, sighs, and otherwise consumes his energy extravagantly. As he improves, his activity becomes narrowed down to the essential movements, with the sloughing off of needless concomitant activity. In the early trials in tracing a star by observing its reflected image in a mirror, the adult student does practically the same things, with laughter or giggling, blushing, and multifarious comments and vocal expressions. In this experiment students frequently bite their tongues, and some press so hard on their pencils that they break the lead. Usually by the fifteenth trial the superfluous activity has largely disappeared and the student goes through the process of drawing the star in a direct and efficient manner.

Trial-and-error learning. When animals, children, or adults are confronted with a new situation in which they do not know how to do what they want to do, they make use of activity patterns they have already mastered. In such a case they may try out one after another various ways of reacting until they hit upon one that brings success (7). Learning by this method is called *trial-and-error* learning. It makes up a large part of animal and human learning. It is the method employed whenever one is unable to execute the appropriate responses or when he does not know what they are. It is frequently relied upon in the process of thinking out the solutions of problems.

Features of trial-and-error learning. There are four characteristic features of trial-and-error learning. First, there is some sort of motive that arouses and sustains the activity. This motive may appear in the form of a need, a problem, a goal, a purpose, or some form of discomfort. Essentially, the equilibrium of the organism is disturbed, tensions are developed, and a need or desire for adjustment is felt. This impels the organism to react to the situation in an effort to come to terms with it. In the second place, several different kinds of responses are made to the situation. Here we have our principle of varied activity in operation. Third, we see the progressive elimination of the superfluous, unsuccessful, or wrong forms of activity. Finally, there is a progressive integration and establishment of the reactions by which the goal is achieved.

Determiners of variability. While the major aspects of the problem or prompting need may remain approximately the same, the variations in the individual's reactions in trial-and-error learning are brought about by various minor shifts and changes in the stimulating and regulating conditions. The consequences of the various attempts are important in this respect. When a reaction fails to satisfy the motivating conditions and when its effects are distasteful, competing tendencies assume control and lead to other forms of response. The reactions themselves bring about changes in the stimulating conditions, which in turn lead to new forms of behavior. A turn of the mechanical puzzle, for example, provides a new aspect of the parts, and each excursion into a blind alley of a maze provides new perceptual experiences and proprioceptive stimulation that may serve as determiners of variations in the learner's reactions.

Illustrations from animal learning. Many experiments have been made on the learning of white rats in various forms of mazes. In a typical experiment of this sort, a hungry rat is placed in the starting box. From the experimenter's point of view the rat's problem is to learn the shortest route to the food box. But at first the rat does not know that there is food in the maze; so, strictly speaking, this cannot at first be said to be the rat's problem. Being hungry, however, he is disposed to look for food anywhere. He may also want to escape from the maze. At any rate, the rat, when released, starts running around exploring the maze. He dashes into one blind alley after another, sometimes passing the openings, occasionally turning into one to find a new area to explore. Sooner or later in this haphazard fashion he finds his way to the food. Without doubt it is an agreeable experience for a hungry animal to discover food. A relation is established between the maze situation and food.

Food becomes an objective, and each additional trial affords the rat another opportunity to improve his performance by eliminating futile excursions. Finally after many trials he goes directly to his food without mishap, over the most direct route. The appropriate turns and runs, and only these, become consolidated into a performance which takes the rat to his goal quickly and with much less effort than was manifest in the early trials.

Varied activity is seen here in the apparently random exploratory running about the maze. If the rat could not have varied his runs, if he could have done nothing but repeat his initial run into and out of his first blind alley, he could not possibly have learned the shortest and most direct route to the food.

Puzzle-box experiment with a cat. The character of trial-and-error learning has been studied in a number of experiments on cats. A favorite device is the puzzle-box used years ago by Thorndike in his studies of animal learning (6). The following account is of one such experiment conducted in the writer's laboratory. It is presented because it demonstrates the essential features of learning at this level.

The subject of the experiment was a cat about eight months old. The apparatus used was a specially constructed puzzle-box two feet long and sixteen inches in width and depth. The sides and top were made of wooden slats 1¼ inches wide and set 1¼ inches apart. On the floor near the rear of the cage was a six-inch slat hinged at one end and slightly elevated at the other. This served by means of levers as a trip for opening the door. A light pressure on the floor slat released the fastener that held the door closed and then the door was thrown open by a spring.

For each trial, the cat was placed in the box and the door was shut. A dish of salmon was placed on the floor outside the box near the door but beyond the cat's reach from within. The cat was given 100 trials, ten each morning and each afternoon for five days. He was fed at the end of each experimental period and then was given nothing more to eat until after the next session. If, after opening the door in any trial, he went immediately to the food, he was allowed a small taste. A complete record was made of the cat's behavior during each trial.

The outstanding points revealed by the results were:

1. In the early stages there was *a great variety of activity,* and depressing the slat which opened the door was just part of the great mass of activity that was taking place. This activity included: looking around, turning, walking about, sticking paws through the opening at the side of the door, poking at the door with nose and paws, scratching the door on the inside, pushing paws out and scratching the door on the outside, sitting down, biting the levers in the cage, reaching for the food with paws, mewing, clawing at a peg by the door, swinging rear of body from side to side, stepping on the slat which opened the door or sitting down on it, backing into it, smelling the floor, pushing nose between the slats at the top, and reaching with paws for the lever on the top of the box.

2. *The situation was problematic.* The cat wanted to get out. He was hungry, and the only way to get to the food was to escape from the box. He did not know how to get out. All he could do was to keep trying with all the means available. He had to experiment, and he experimented by doing just about everything a cat could do in such a situation.

3. It was indicated that *the "successes" in the early trials were accidental* in the sense that the cat saw no relation between pressing down on the floor slat and the opening of the door. In the first series he happened to sit down or step on the slat. This had no more significance for him at the time than biting or clawing the door. In some cases he did not even notice that the door had opened for several seconds after he had released the fastener. He opened the door a few times by just falling over the slat.

4. There was *a gradual elimination of useless activity* as the cat was called on to repeat his performance in successive trials. It is significant,

moreover, that elimination took place in the case of action that had been repeated dozens of times—an example of the fact that repetition alone does not serve to "stamp in" a mode of response.

5. After the cat had opened the door several times in the early part of the experiment by awkwardly backing onto the slat, sitting on it, or stumbling over it when backing from the door, he apparently *related his backing up with escape.* For trial 23, the record states: "Looked through left-hand corner of box. Looked at the top. Backed around the box and sat on the slat. As soon as he backed into the slat he turned to look at the door." He followed the backing procedure for many trials. At this stage in his "knowledge" he doubtless would have argued stoutly with his feline companions that he knew walking backwards caused the door to open. That he had not yet grasped the relation between pushing down the slat and the opening of the door is shown by the several instances in which he stepped completely over the slat while backing. When he did this, he continued walking backwards all the way around the cage. Sometimes he missed the slat on his second and third backward tours of the cage. In trial 24, for example, he backed over and missed the slat three times, and each time he turned to look at the door. But he kept on backing around the cage and finally opened the door by sliding backwards over the slat. (One is reminded in this connection that certain theories are defended on the ground that they work out in practice. Some beliefs that have "worked" have been found later to be as unsound as this cat's notion that his walking backwards was what made the door of his cage open.)

6. *The awkward backing method of attack was eventually abandoned,* in spite of its success and repetition, in favor of the more dignified and efficient procedure of opening the door by directly pressing on the slat with one of his front paws.

7. As the trials went on, there was *a gradual discovery of the relation between pushing down on the slat and the opening of the door.* This discovery, indicated by the cat's looking toward the door as he pressed the slat down, gave new significance to the slat and the reaction to it. In the 58th trial the subject pawed the slat, pushed it up, and then turned to look at the door. He poked at the slat again, and once more turned to look at the door. It had not opened. He then pressed down on the slat with his front paw, saw the door open, and came out. Behavior of this sort continued through several trials at this stage of the experiment. There was, however, a gradual reduction of the useless activity preceding the successful thrust. In the 65th trial the cat clawed the slat first and looked at the door. Then he turned and pushed down

on it vigorously. Toward the end he walked straight to the slat and pushed it down with his paw without any useless activity.

8. There was a gradual *differentiation* and *consolidation,* and to some degree *fixation,* of the movements appropriate for the quickest and most direct solution of the situation. The behavior became effectively organized with respect to the goal.

9. Throughout the 100 trials of this experiment the *cat's behavior was not a response to an isolated stimulus,* but to a whole constellation of factors making up the entire problem situation. The food was a stimulus-object, but the cat acted as he did because the food was outside the box, beyond his reach, and he was inside and hungry.

We learn by trying. We learn to do what we want to do by attempting over and over to do it. In our repeated efforts we try out various ways. If we do not try, we will not learn. A child learns to write by trying to write. His hand will shoot off the proper course many times. There will be many false or useless reactions to be eliminated. His coördination will be poor at the start. But his performance will improve as he keeps trying. Eventually he will single out and organize the right movements. Multiple activity is conspicuous in the initial stages of all learning involving the development of motor skills, such as swimming, tennis, speech, and bicycle riding. It is seen in the "try-and-try-again" efforts of an adult attempting to solve a mechanical puzzle. Moreover, varied activity is found in learning on the ideational level, though here it is not usually called *trial and error.* In solving problems by thinking an individual tries one suggestion after another, testing each of them in the light of past experiences, discarding those found inadequate, and continuing the search until a satisfactory solution is found.

Learning improves with the acquisition of resources. When the movements essential for success are not known or when their control has not yet been developed, we are likely to have a great amount of the massed sort of activity, as in the case of a baby of three months reaching for a dangling ring, or the child of five years trying to write the letter *A.* But as an individual acquires experience and mastery of many movements, he uses them more and more in his solution of new situations. His varied activity takes the form of a more orderly succession of various modes of attack, and at the higher levels of problem solving the use of memory and imagination reduces overt trial and error.

Animal and human learning. Human learning is usually superior to animal learning. This is due in part to the fact that human beings are able to react in a great variety of ways, and in part to the fact that they are more adept at carrying over and applying old skills and acquired knowledge to new situations. In human learning the various possibilities are tried out and checked off more systematically. The animal repeats his failures more often and is slower to perceive significant relations. The human learner advances faster also because he can remember what activity failed and what activity brought success.

But animals are able to modify and adapt old methods to the requirements of a new problem. This is sometimes done quite suddenly and in such a way as to effect an immediate solution. In such cases the marked change in behavior or the direct thrust at success is said to be due to *insight*. This is regarded as a step above trial-and-error learning.

No learning without activity. We learn by actively attempting to reach our goal. If there is no response to the problem situation, there will be no learning. At one time the writer attempted to show a group of students the varied activity of a cat placed in a puzzle-box. The group was warned to be quiet so as to avoid distracting the cat. The animal started out well enough. She was giving a good demonstration of the variety of things a cat can do and does do in learning to escape from such a situation. Then one of the students dropped a book, making a sudden loud noise. Instantly the cat stopped stock-still. She stood motionless for a moment, then settled down on the floor and remained there. There was no more action. The demonstration was over. So long as the cat refused to try, there was no chance of her learning how to get out of the box. It is the same with children and students. We cannot get them to learn if they will not put forth an active effort. Only through activity can learning take place.

Summary of the Chapter

The ability to vary one's mode of attack upon a problem situation is a basic factor in certain elementary forms of learning. The characteristic course in the development of behavior is from mass activity, involving many forms of response made simultaneously and in succession, to specific and effective modes of reacting. When the learner has a goal but does not know what steps to take in order to reach it, when he lacks insight, or when he lacks the ability to produce the correct form of response even though he knows what it is, his method of learning will probably be of the trial-and-error sort. This method is found to a great extent among animals and it is characteristic of the cruder and more primitive forms of human learning. In this method the learner tries out, one after another, various modes of reacting to the situation until he hits upon one that produces satisfying results.

Under repetition of trials the useless responses and roundabout procedures tend to be eliminated, and those which bring the learner to his goal in the most direct manner are selected and consolidated. Trial-and-error learning demonstrates clearly the fact that activity is essential for learning. As one's resources in the way of mastered movements and understanding increase, there is less dependence on overt trial-and-error procedures. Since human beings usually possess greater resources of this kind than animals, they surpass animals in their ability to learn. They more frequently employ methods superior to trial and error.

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CHAPTER V

REPETITION

The principle of repetition. *The repetition of a function provides opportunities for its progressive modification and fixation.*

Repetition has been recognized generally as essential to the mastery of most school subjects. Common observation indicates that it takes practice to develop all but the simplest of skills, that drill is needed for the establishment of specific verbal responses, and that lasting memory for subject matter requires review. Since the teacher is charged with the responsibility of engineering the activities by which these ends are to be achieved, it is important that he understand clearly the role of repetition in the learning process. In the interest of clear thinking and justifiable practice, we must consider the following questions in the light of available evidence. First, what is it that is repeated? Is it the situation? Is it the learner's performance? Or is there simply a renewed attempt on the part of the learner to reach his goal? Second, to what extent and under what conditions does repetition effect modification and fixation?

The question of repetition. In the first place, we must bear in mind that where learning is actually taking place, there is modification of function. This means not simply the repetition of a performance in the sense that the learner does the identical thing over and over. The function does not recur in identical form because each time it is carried through, a change is produced in the learner, and this change in the learner brings a change in the form of the function as it is renewed. Thus, in learning we do not merely repeat a performance; we alter it. Otherwise we would not have improvement, and the acquisition of new modes of response would be impossible. Of course, if we regard only the end term of function, the "response," we find, as we approach habituation or after a considerable amount of memory drill, a certain uniformity. The response may then recur in approximately identical form. Even here, however, if learning is still taking place, there may be change with regard to the fixation and consolidation of the performance. When there is no longer any change being made in the function, learning has ceased. Strictly speaking, then, the function or performance is not repeated. It is renewed, and in its renewal it appears in modified form.

The law of exercise. The role of repetition in learning as viewed by the connectionist has been stated by Thorndike and others in the *law of exercise, or use, or frequency* (2). This law states that the bond by which a stimulus is linked with a certain response is strengthened by exercise or use, that is, by repeatedly making the response to the stimulus with which it is connected.

The frequency of the situation. This statement of the relation of repetition to learning has been found to be inadequate in a number of respects. It has been criticized on the ground that it does not account for the fact that the learner changes his performance from trial to trial, and that in many cases repetition does not bring about such an alleged strengthening of the response tendency. Thorndike has vigorously attacked the problem by means of many experiments and has presented his modified views in his later writings (3, 4). In *Human Learning* (3*a*) he raises the question concerning the effect of the frequency of a situation. He refers to the former acceptance of the view that the mere repetition of a situation in and of itself produces learning and then states that this is not true. In an experiment involving 3,000 attempts to draw with eyes closed a line four inches long, the lines drawn in the last two of the twelve sittings were not drawn appreciably better than those in the first and second sittings. The repetition of the situation was not sufficient in itself to cause learning. Here the learner had a task, a goal, but no way of knowing how far he fell short of it each time, and no way of knowing in what way to change his performance in order to improve it. The need for some kind of check or appraisal of achievement in terms of the desired outcomes is indicated by the results of this experiment.

Another experiment is reported by Thorndike (3*b*) in which a long list of two-letter combinations was presented to the subjects, who were instructed to regard these letters as the beginnings of words that they were to complete. Some of these beginnings were repeated twenty-eight times. The subjects did 240 completions each day for a total of fourteen days. For completing the word beginning with *el* one subject wrote *ephant* and *evate* twice in the first seven trials. For all of the last eight completions this subject wrote *f*. In spite of the early repetitions of the longer completions, they disappeared in favor of the shorter and more easily written *f*. Here again is shown the inability of repetition to perpetuate a particular response. A shift and a substitution are made in the interest of completing the task more quickly and with less effort.

Repetition of events in sequence. Thorndike also raised the question of whether repetition or frequency of a connection can produce learning. Here the word *connection* refers to two things presented to the learner in immediate sequence. If, for example, one word follows another repeatedly, will the mere occurrence of these words in this order cause them to be learned so that later the presentation of the first will enable the subject to recall the other? The results of Thorndike's experiments led him to the conclusion that repetition of items in temporal contiguity has very little or no effect in producing learning, unless there is in addition to the sequence the element of "belonging." By this is meant a sense of relatedness or the feeling that the second member in some way belongs to the first. This was demonstrated in an experiment in which ten sentences were read to a group ten times. The sequence of the last word of one sentence and the first of the next had the same frequency as the first and second words of each sentence. However, the first two words were the name of a person. The second word belonged to the first in that it was the surname. The ability of the subjects to tell what word came next after the last word of a sentence was exceedingly slight. The subjects were much more successful in giving the word that came after the first word of a sentence (3*c*). This matter of belonging is of such importance that we shall consider it later in connection with the principle of relationships and organization.

Repeated contacts without attention. Repeated encounters with an external situation or part of a situation are not likely to produce learning when they bear no relation to the individual's purpose, interests, task, or problem, and, for that reason, do not claim his attention. This fact may be demonstrated experimentally by instructing our subjects to watch for one thing and then later by asking them to recall something else not mentioned in the instructions. Such a demonstration is made by presenting to a group of students a series of cards, each bearing a printed word, a number, and a strip of colored paper. The subjects are instructed to observe closely the word and the number on each card so that later when each word is presented alone they may supply the number which goes with it. No mention is made of the color to be presented with each word. After several presentations, the students are asked to give the color that was presented with each word as well as the number. The score for colors is found to be much poorer than for numbers. Frequently, some of the subjects will protest that they were not told they would be asked about the colors and so did not pay any attention to them. They did not learn them as they did the numbers, not because of a difference in frequency of presentation, but because they were not set to observe them. Usually, a few students in such an experiment assume that the colors do have something to do with it and instruct themselves to watch them. Such students may make a good score on the color test.

Many such experiments and analogous illustrations from everyday experiences could be cited. One may go up a stairway every day for twenty years without being able to remember how many steps there are in it. We may be grossly ignorant of the details of the most familiar situations, because they have escaped our attention and because they were not significant for us. But these cases do not in the least contradict the fact that the renewal of a function is a factor of prime importance in developing skills and in acquiring understanding. They indicate simply the necessity for the proper motivation. The individuals who failed on the unexpected questions had not perceived the colors, or the number of steps. What they had not observed, they could not recall. A student who sleeps through a lecture or who spends his time writing letters cannot be expected to learn much from it, and repeating the lecture to him under such conditions would be of no avail.

Repetition and the trial-and-error procedure. In the previous chapter cases of trial-and-error learning were mentioned in which reactions that had been repeated many times were eventually eliminated in spite of their repetition. Futile movements were dropped out. If repetition of itself strengthened the tendency, one should never be able to rid his performance of his early mistakes, excess motion, and crude methods. Not only do repeated futile movements disappear in the course of learning under renewal of function, but relatively inefficient methods of reaching one's goal, that is, responses which have been successful, even though practiced for some time, are given up for short cuts to the goal, or for easier and quicker methods of reaching the desired objective. The cat gave up backing around the cage, though she had repeated that procedure many times, and substituted pushing down the slat with her paw. The latter was a more efficient means of opening the door of the cage. In an experiment by Higginson (1) with white rats, a run into a blind alley of a circular maze, repeated 100 times, was eliminated almost at once when a change in the maze made it no longer necessary.

Original responses sometimes weaken and disappear under repetition. Not only are the useless responses that occur in the mass of varied activity characteristic of trial-and-error learning eliminated in spite of their frequency, but sometimes specific reflex responses, occurring promptly and dependably at the outset, subside and disappear when the stimulus evoking them is repeated a number of times. The original tendency linking the response with the stimulus, instead of being strengthened by exercise, is weakened and sometimes eliminated. Let a student put his nose against a pane of glass, and then let a felt hammer strike the glass opposite his eyes. At first his eyes will blink sharply. Repeat the procedure fifty times. As a rule there will be a diminishing of the wink reflex, and in some cases it will subside to the point where no response is observable. White rats rotated in small cages in an experiment by Griffith at first showed signs of disequilibration in their behavior, but later, as rotation continued, these reactions disappeared. Rotation of human subjects usually causes nausea, dizziness, and nystagmic eye movements. These movements tend to disappear as rotation sessions are repeated over a period of time. The reactions producing seasickness become less pronounced or fail to occur after repeated encounters with rough water. Loud and distracting noises may be wholly unnoticed as one becomes accustomed to them. The organism develops an immunity, as it were, to the stimulus. The function is modified, but the change is toward no response, not toward establishing it more firmly. This seems to occur where the response has no value for the organism. The principle involved seems to be the same as in the case of pruning one's performance in trial-and-error learning.

Learning from a single occurrence. Sometimes a single occurrence of a function, or, as we frequently say, a single "experience," is sufficient to change the character of one's activity. One reading of a lesson may enable the student to make a respectable recitation. Hearing a name once may enable one to speak this name later. One glance at a new word may be all that is needed in order to learn its correct spelling. A child may recite five digits after hearing them once. A single visit to a museum equips one with a fund of information. An exciting mountain climb or a successful fishing trip provides a host of memories. A solution of a problem once thought out is remembered, and in a subsequent encounter with a similar situation memory instead of problem thinking is employed.

Since learning takes place through the exercise of a function, it is to be expected that some learning would result from a single instance. How much learning is derived from a single functional event will depend on other factors, such as interest, attention, significance, insight, task, and the kind of learning. We may not expect, however, the same degree of learning from one instance or one trial as from many, at least in the kind of learning we usually try to promote in the classroom.

It is probable that a single occurrence of a function often fails to produce demonstrable learning effects, not because it actually produces no increment of learning, but because other activities that follow provide interference which eliminates or weakens its residual effects. If, for example, a teacher places one German word on the board and tells the class once that it means "dish" in English, probably most of the class would be able to give the English equivalent of that word a half-hour later. But if a list of ten German words is presented and the English equivalent of each is named but once, the class would likely make a poor showing in a test thirty minutes later. The ability to give the meanings in English for the whole list would require repetition.

Renewal of function provides opportunities for improvement. The evidence we have been considering points clearly to a fact every teacher should bear in mind, namely, that the mere frequency of a situation or of a response is not sufficient, in and of itself, for successful practice, drills, or reviews. A child may write a list of words many times without learning to spell them. He may do his penmanship exercises without improving his handwriting. He may do a series of exercises by following the steps indicated in the sample without mastering the principles involved. We sometimes forget or fail to realize that teaching means more than simply placing educational materials before our pupils, and are shocked and perhaps irritated to find that they have failed to grasp a point that we have reiterated.

The role of renewal of a function under recurrence of a situation is seen in the fact that such renewal affords *opportunities* for the progressive modification of the function. It gives the learner a chance to discard false motions or needless and awkward reactions, and to try out short cuts and more efficient methods. It gives him a chance to correct errors and to profit by his experiences. Such opportunity for improvement is essential for most forms of classroom learning. It is necessary, therefore, that the teacher provide the occasions which invite and encourage the renewal of the functions to be improved. Whether these opportunities for improvement will mean anything to the learner depends upon the motives with which he encounters them. Without interest, attention, or purpose on the part of the learner there is likely to be little accomplished. Skillful teaching calls for the clever management of these subjective factors quite as much as the manipulation of external conditions. These factors will be discussed in the following chapter.

Repetition an important condition of learning. Because repetition does furnish opportunities for revision, correction, integration, shifts, substitutions, and consolidation, it is an outstandingly important condition of learning. The emphasis in this section on the fact that repetition alone is incapable of accomplishing learning has not been intended to minimize the value of repetition, but to show that it must be accompanied by other essential factors. Practice involves repetition. The sensorimotor coördination in handwriting, in the language skills, in efficient use of the typewriter, in playing musical instruments, and in athletic skills requires much practice. Mastery of spelling, grammatical usage, and the combinations in arithmetic calls for drill, and drill means repeating certain responses many times. Reviews are necessary to retain information acquired from textbooks. To review is to reinforce impressions by the renewal of the functions involved in the first reading. A skillful teacher provides occasions that encourage the return again and again of a function, for this makes possible the progressive modification of the function in the direction of the goal of learning.

Summary of the Chapter

Repetition is an important condition of learning. It is essential for the progressive modification of the psychological functions. To be effective, however, repetition must be accompanied by other essential ingredients of the learning process. Without attention, interest, meaning, and a goal, repetition is apt to be useless. The mere repetition of situations, or of responses, is not in itself capable of strengthening a functional tendency or of perpetuating a response. In the course of learning, responses which have been repeated many times are frequently abandoned in favor of a more direct approach to the goal. Some reflex responses tend to disappear under repeated presentations of the stimulus which evokes them. A certain amount of learning results from a single occurrence of a function, but it usually takes repetition to achieve the higher degrees of learning. The importance of repetition lies in the fact that it provides opportunity for making improvements in one's performance. It is essential for securing the desired proficiency in many forms of classroom learning, and it is necessary also in the drill subjects and other studies, for the purpose of securing good retention.

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CHAPTER VI

MOTIVATION

The principle of motivation. *An individual's activity and the learning that results from it in a given external situation are determined in part by the pattern of motivating conditions present at the time.*

Learning takes place through activity, and the outcomes of learning are determined by the nature of the activity. Good teaching, therefore, secures activity which produces the desired outcomes. The activities of an individual are governed by many factors, and the management of the learning process calls for the control and manipulation of those factors that initiate and direct the appropriate learning activity. It follows, therefore, that the teacher needs to understand as fully as possible the fundamental controls of human activity.

The activities of an individual are determined by a complex of factors some of which are found within the individual and some of which are external to him. All of these factors taken together constitute the *total psychological situation*. It is the purpose of this chapter to consider the internal factors of control, but since these operate in conjunction with external factors and can be properly understood only in relation to them, we shall approach our subject by referring first to some of the features of the external situation.

The external situation. Common observation reveals that we react differently to different objects in our environment. We skate on the ice, sit in a chair, read a book, wear a hat on our head, and eat food. The normal person will not try to skate on the chair, eat the book, or wear his hat on his foot. Thus, the objects or other features of the external situation have a way of dictating certain modes of behavior. Moreover, the color we see depends upon the light waves that fall upon the retinas, and the tone we hear depends upon the vibration frequency of the air waves that strike the ear. A memory is aroused by the sight of some object, and the printed words determine in a large measure the course of our comprehending. The shout of "fire" arouses fear, and the broken lock elicits problem thinking.

In the classroom the books, materials, and the words and actions of the teacher are components of the external situation that invite learning activity and to a large extent regulate its course and character. The selection and control of such factors constitute an important part of the teacher's task, for what the child learns will depend in a large measure upon the character of the materials presented to him, the exercises assigned, the stories he hears, the pictures he sees, the lectures, demonstrations, words of encouragement or reproof, rewards, the conduct of other children, the teacher's mannerisms, and the marks on his written work. Efficient instruction requires skillful management of these factors.

INTERNAL FACTORS OF CONTROL: MOTIVES

Granted that the external situation exercises considerable control over one's activities, we are, however, confronted by the fact that different persons often react very differently to the same external conditions. The organism is not wholly at the mercy of stimuli presented by its environment. The external factors are not the sole determiners of one's behavior. How an individual reacts to a given set of environmental conditions is governed in a large measure by factors of control within him.

In the first place his reactions depend upon the nature of his own *physiological mechanisms* for receiving stimuli and for making responses. The behavior of human beings differs from that of lower animals partly because of differences in anatomical structure. But beyond this, in human beings are found *governing sets or predispositions* which determine the nature of the activity in a given environmental situation. These sets are in the nature of inclinations toward or states of readiness for certain forms of functioning. They include *governing tendencies* and *motives* which determine the nature of the response and steer the course of activity much as the set of a sail determines the course of a ship for any given direction of the wind. Our present concern is with those forms of set, usually called *motives,* that serve to initiate certain forms of functioning as well as to direct their course. We shall consider some of the principal forms of motives.

The physical needs. Since we are biological organisms, our inherited nature provides certain *unlearned motives* in the form of bodily needs. We have here the motives of hunger, thirst, sexual desire, and various forms of bodily discomfort. The hunger pang is the conscious correlate of the bodily need for food. It sensitizes us to food stimuli, sets off activity in search of food, and induces eating when food is available. In the absence of hunger the most delicious food may be completely ignored. Thirst arises from the bodily need for water. It prompts us to seek out water and drink it. The need for air causes vigorous activity to escape from suffocating conditions. Likewise, various forms of activity are prompted by the need for exercise when rested, the need for rest when fatigued, the urge to escape from pain, and the need for maintaining the bodily temperature within limits imposed by nature.

These are the primitive and fundamental motives. They do not have to be acquired by experience. They are found in the lower animals as well as in man. They are the foundation upon which learning builds up a complex superstructure of acquired motives. They are strong and selfish. They do not require reinforcement by social approval as do the acquired altruistic motives, although they early become enmeshed with the latter. Their satisfaction is, for the welfare of the social group, restricted and regulated by customs and traditions.

While most of these motives have been employed in experiments on animal learning, they are not usually invoked to secure classroom learning. However, since they are natural and powerful drives, turning the individual toward certain forms of activity, their presence may so dominate the child's reactions as to make him utterly unresponsive to the teacher or his books. Pain, fatigue, hunger, thirst, romantic yearnings, or the need to urinate may on occasion quite overwhelm the desire to secure good grades or to please the teacher.

Habit. A large part of our behavior is governed by habit. While we skate on the ice, sit in a chair, and wear a hat on our head, we react to these objects as we do, not primarily because of their demands upon us, but largely because of our own acquired predispositions to react to them in these ways; that is to say, we do so because of our own habits. Insofar as habits prompt as well as regulate behavior, they serve as motives. The prompting role of habit may be seen in the case of smoking, brushing one's teeth, and in the urge to get to work when the regular hour for study has arrived.

Other functional trends. In a like manner all the other psychological functions are initiated and run their course under the control of functional trends which, like habits, are the products of previous learning. Thus, what we perceive when we look, hear, or touch, depends only in part on the stimulus-pattern, and largely upon our acquired perceptual predispositions. The meaning we attach to the words spoken by another, the memories that appear, and the emotional stir are determined mainly by the functional trends formed by learning. The child reacts to the instructional situation presented by the teacher and classroom according to his own proclivities derived from his former activities. All pupils will not react alike because their backgrounds are not alike.

Social motives. When the child is still very young, he develops a number of social motives that greatly influence his behavior in social situations. These appear to grow out of his physical wants and are related to the means of satisfying them. He learns early the value of the approval of other persons, particularly his elders. As a consequence, social approval soon comes to be valued, desired, and sought. He is rewarded for outmaneuvering his playmates. He acquires the desire to win in competition, to assert himself, to display his prowess, and to gain esteem. He finds security, satisfaction, and comfort in companionship with others and so develops a strong gregarious tendency. These social motives affect his classroom activities. He may work hard to please the teacher or to be able to take a specimen of his work home to his parents. He may work for and prize good marks, for they signify the approval of the teacher and bring satisfactions in the form of parental commendation. He wants to surpass other members of his class, for that brings prestige and self-esteem. He may be induced to study diligently if the reward is participation in social activities. To be deprived of the company of his fellows is for him a severe punishment.

Attitudes. Another form of set that greatly affects a child's reaction to instruction, one that is more generalized in its influence than habit, is attitude. This is a very prevalent form of control. It is often not clearly recognized, frequently not understood, and in many instances difficult to manage. It differs from habit in that it affects many forms of activity, and it serves to govern activity in a wider variety of situations. The nature of attitudes and methods of developing desirable ones will be discussed more fully in a later chapter. Here we must consider them as one of the forms of set with which the child encounters the learning situation.

The attitude of indifference on the part of a child toward his work is a trying one for the teacher. To overcome it requires patience, skill, and understanding. It may be due to some fault of the teacher, or its cause may be in the home or elsewhere. Whatever its cause, it precludes earnest endeavor and retards achievement. A dislike for the teacher or an antagonistic attitude toward him will undermine his efforts to secure good results. The child who feels that his teacher "has it in" for him, or who believes his teacher thinks he is "dumb" is not likely to do his best for that teacher. Taking a course simply to secure one more credit toward a degree rather than seeking to obtain some real value from the course itself is an unfortunate attitude sometimes found among college students. A cynical attitude that keeps a student from seeing anything in his courses worth working for will prevent the best instruction from accomplishing its purpose. An attitude of discouragement interferes with one's best efforts, and a feeling of inferiority or insecurity prevents wholehearted endeavor. Fear of failure, excessive timidity, and lack of self-confidence are attitudes that prevent one from reaching the fullest possible measure of success. These are some of the unwholesome attitudes teachers should be quick to recognize and then do their utmost to remove.

There are, on the other hand, attitudes favoring learning. Interest is an emotional attitude essential to first-rate accomplishment. Interest may be centered in the learning activity itself, or it may be centered in the goal of achievement, in the ability to be acquired by learning, or in other rewards of effort. Other attitudes conducive to good work are self-confidence, a sense of security, goodwill toward the teacher, willingness to coöperate, and respect for good scholarship.

So much attention has been given in recent years to intelligence and its relation to achievement that many teachers are prone to attribute all poor work to mental dullness. It should be remembered, however, that a bright or normal child may do poor work because of the wrong kind of attitudes. Such a child may have become bored or wholly discouraged with his schoolwork. Then he is given an intelligence test. This being to him just another disagreeable school task, his test performance is halfhearted. He gets a low score, and then his poor progress is falsely attributed to dullness. On the basis of the test score he may be placed in a special class with real dullards where his situation becomes more and more intolerable. Intelligence tests have been so oversold to our teachers and in so many cases unwisely used that now the psychologist finds it necessary to emphasize their limitations and warn against their improper and ill-advised use. It is time that our emphasis on intelligence be tempered by a more adequate consideration of the equally important matter of attitudes.

The task. The set or motive that governs purposeful or voluntary action is called a *task*. While not independent of the influence of the individual's past activities, it is not, like habit and attitude, carried over directly from the past but is formulated under the demands of the present circumstances to provide action that will satisfy these demands. The task is a transient form of set, for it ceases to exist as soon as its action goal is reached, and when the action it sets off is repeated many times, it is replaced by habit. It involves foresight of the goal of action, and commitment to a course designed to reach that goal. It is sometimes called *intent, purpose,* or *decision.* It is what we imply when we say we have decided to do a certain thing or that our "mind is made up."

The formulation of the task is normally followed by the steps or functional phases that bring the individual to his goal. It is not presumed that the task is merely an idea of an end to be achieved and that this idea directly causes the body to carry out the action. It is assumed, rather, that the neural mechanisms are set to function in such a way as to produce the movements necessary to bring the individual to his goal. A set for a particular goal favors activity leading to that goal and tends to inhibit other activity.

Sometimes, however, the course of action is interrupted by the intrusion of some new object of attention, or by the shift of attention to a different goal. This may result in the disruption of the task to the extent that the individual abandons his course before he has finished what he set out to do. People differ in persistence and in ability to maintain their course in the face of such intrusions. Young children, in particular, are susceptible to the disturbing effects of distractions. They easily lose sight of their goal and leave the undertaking unfinished when a new object of interest appears. Binet considered the ability to formulate and maintain this form of set an important feature of intelligence (27).

Three sources of the task have been distinguished by Bentley (2). These are: first, the demands of the occasion; second, instructions received from another person; and third, instructions which one gives to himself, or "self-instruction." When the lawn-mowing task issues from the sight of the long grass, the source is of the first of these three varieties. So, also, the rain beating through the open window arouses the action-set for closing the window, and the ripened grain calls on the farmer to begin the harvest. When a boy washes the car because his father has told him to do so, the set governing his performance is derived from the instructions of another. The teacher's assignment is a form of instruction designed to produce a set for certain forms of learning activity. The child in whom the appropriate task is not established will fail to carry out the teacher's instructions. In the case of self-instruction the task arises, not from outward circumstances or from directions given by another person, but from one's own interests, wishes, or needs. When a child, without being requested to do so, brings to the teacher a newspaper clipping bearing on the lesson, he does so from self-instruction.

In laboratory experiments on human learning the formal instructions to the subject are an important part of the procedure (20). They are usually prepared with care and often are written out to make sure that all subjects are instructed in exactly the same way. By means of instruction the experimenter seeks to extend his control of conditions to the set governing the subject's performance. Thus, a subject may be set by the instructions to respond to a given signal by flexing his forefinger, depressing a chronoscope key, making a series of rapid pencil strokes, crossing out certain letters on a page of printed material, or any other activity suited to the purposes of the experiment. The instructions give rise to the task or preparatory action set, and this, in turn, determines, within limits imposed by other conditions, the nature of the subject's performance.

An experimenter is frequently confronted with the entrance of self-instruction into the experimental picture. The subject may on his own account adopt a mode of procedure somewhat different from that requested by the experimenter. Such self-instruction may materially affect the results, and the experimenter must be alert to detect such influences. In the mirror-drawing experiment, for example, where the subject traces a star while looking at its reflected image in a mirror, the subject is formally instructed to draw as rapidly *and* as accurately as he can. Not infrequently, however, a subject decides to "go in for" speed to the neglect of effort toward accuracy, or to slow down deliberately in order to reduce the number of errors. It is obvious that the influence of self-instruction must be taken into account in interpreting experimental data.

While self-instruction that leads a subject to deviate from the experimenter's directions, if not detected, may be detrimental from the standpoint of the reliability of the experimental results, in the affairs of daily life it usually means self-reliance and initiative. It may mean the independent selection by a student of a course of study or the decision to devote more time to one course than another because of the conviction that it offers greater values.

The problem. As in the case of the task, the sources of the problem are instructions: first, from the occasion; second, from another person; or third, from one's self. Problems arise, in other words, from frustrating circumstances, as when the car will not start; from the symbolic presentation in the words of another person of a situation demanding a solution, for instance, when the teacher asks a question that can be answered only by deductive thinking; or they may issue from our own desire to discover new truth, as when one formulates a problem for scientific research or when one seeks the least expensive method of getting home for the holiday vacation.

The problem has been described as a "felt difficulty" (13). It is not the difficult situation itself, nor the printed words, nor the question asked by the teacher. It is the mental and bodily set induced by these challenging factors. It is a set initiating and governing the thinking which leads to the solution. This solution may be a plan of action by which the difficulty is surmounted, an answer to a thought question, or a conclusion that satisfies an intellectual inquiry. The problem is an important factor in learning because it governs one of the most effective forms of learning activity. We shall consider it further in the discussion of problem-solving thinking.

The instructions from the occasion or from another person vary in degree of definiteness. When they are not sufficiently definite to provide a clear-cut problem, they may be supplemented by self-instruction. Also the instructions from another person may supplement or reinforce the occasional instructions when the latter are insufficient or indefinite. For example, a child may see on the blackboard the numbers

$$\begin{array}{r} 31 \\ \underline{4} \end{array}$$

From seeing these alone he might be expected to add, subtract, or multiply to get the answer. The occasion would probably call for addition if this came in a series of exercises in addition or if the child had not yet studied subtraction or multiplication. If, however, this arrangement of figures appeared in a review where all three operations were presented in mixed order, the teacher could help the child complete the formulation of his problem by saying "add" or "subtract." In the absence of supplementary instruction from the teacher or a sign to indicate which operation was to be carried out, the child could instruct himself; that is, decide for himself which operation to perform. In any case, the problem formulated by the child will determine whether his answer will be *35, 27,* or *124.*

In a word-association test the child may be instructed to respond with the word that he thinks of first after hearing the stimulus word, or he may be instructed to respond with a word that means the opposite of the word spoken by the experimenter. In the latter case the range of his possible responses will be more restricted, and his set will tend to inhibit even the thought of words that are not opposites. This control of the associative processes may be demonstrated by the use of skeleton words where dashes replace part of the letters, as D–W–. The student is instructed to make a real word by filling in the missing letters. Now if we tell a class we are going to place on the board such a skeleton word to be completed to make the *name of a piece of furniture* and then write L–M–, most of the students will immediately think of *lamp.* Other words that might have appeared if the instructions had not restricted the response to furniture, such as *limp, lame, lime,* and *lump,* are usually not thought of at all. The furniture set tends to block other word responses. Thus, the individual reacts according to his purpose or problem.

The ideal. When one's goal is broad enough to initiate, sustain, and regulate a wide variety of activities, it is called an *ideal.* Take, for example, the ideal of success. The individual in whom this ideal is established has a more or less definite conception of the meaning of success and regards it as a desirable achievement. For him success is an aim and he is set or disposed to do those things which he believes will contribute to its realization. The activities over which this ideal exercises a controlling influence are numerous and varied. They may include the many different activities involved in getting an education, such as diligent study, regular class attendance, attention to lectures, careful preparation of assignments, participation in class discussions, and intensive reviewing for examinations. This ideal may affect the selection of courses of study, vocational choice, plans for summer work, and participation in student life.

The ideal is like the task in that it involves conscious purpose or foresight of an end to be attained, but it differs from the task in two ways: Its sphere of influence is broader than that of the task, and it usually persists over a longer period of time. In its breadth of influence and durability it is like the attitude, but it differs from the attitude in that it involves a foresight of end or goal not found in the attitude.

Combinations and conflicts of motives. The various motives which we have been considering usually appear not singly but in groups. Sometimes the pattern of motivating sets is very complex. When several motives are present, there may be either mutual reinforcement or conflicts between them. Thus hunger reinforces the habit of eating. The desire to excel other pupils, to get good grades, to please parents, to win the favor of the teacher may all combine with the ideal of becoming a famous surgeon to reinforce the task derived from the assignment made by the teacher. In conflict with these motives may be desire to go to the movies or to play in a game of football that would take the time necessary for preparing the lesson. Our behavior is often the result of the net driving effect of a multiplicity of motives some of which impel us toward a certain goal while others tend to hold us back.

Sometimes it is not merely the question of doing or not doing a certain thing, but of choosing between two courses of activity or desired goals where the selection of one means giving up the other. Here the choice will be made in favor of the action that has behind it the stronger total motivation. In attempting to motivate schoolwork, the teacher must recognize the intricate intermingling of motives in the child. He must take account of the motives that tend to draw a child into other channels of activity, and utilize all available motives to reinforce the task for preparing the assignment.

The Role of Effects and Consequences

The subject of motivation necessarily involves the influence of the effects and outcomes of an activity upon the tendency to repeat that activity, that is, upon its fixation or elimination. The view that rewards and satisfying outcomes encourage the repetition of an act and that punishment or annoying consequences tend to discourage or prevent recurrence is an old and firmly established tenet of common-sense psychology. It has been the keynote of most animal and child training, and in the treatment of criminals it has been axiomatic. We praise and reward the behavior we wish to see continued or developed, and punish that which we want to prevent. While this practice is based on an important psychological principle, it has sometimes been unsuccessful or its success has been limited because the relation of effects to the fixation or elimination of an activity or response has not been fully understood. Many scientific investigations have sought to discover the influence of annoying and satisfying aftereffects on the functional tendencies.

Since learning is a process of developing and modifying the functional tendencies, any factor which operates to strengthen or weaken a tendency for certain forms of activity is an important condition of learning. A large amount of experimental data indicates beyond a doubt that the consequences or aftereffects of a function, as well as its operation in course, do serve to increase or decrease the disposition to repeat that function and, therefore, that they promote its fixation or its elimination. The same may be said for parts of a function. Thus, if a hungry animal upon entering a compartment finds and is allowed to eat food, he appears more willing and ready to enter it a second time than he does if he receives an electric shock upon entry. A child painfully shocked by putting his finger into an electric light socket normally avoids putting his finger in such places afterwards. The child who enjoys his schoolwork will, as a rule, make more satisfactory progress than one who finds it distasteful or painful.

Pleasant and unpleasant effects. The influence of the affective quality of the consequences of a performance upon one's inclination to repeat or avoid a similar performance has been the theme of a number of theories of learning. Pleasure and pain were held by several earlier writers to account for the selection of certain responses and the elimination of others in trial-and-error learning (8). But later writers have not found in pleasure and pain a satisfactory explanation of selection, fixation, and elimination. Rejected responses are not always unpleasant and accepted responses are not always pleasant (6). Moreover, in experiments on animals the affective quality of the effect cannot be known, and in those employing human subjects it can be known only through the subjects' reports. Later writers have been inclined to consider effects in terms of behavior, with satisfaction being regarded as a state of affairs which the individual readily accepts, seeks to continue, or does nothing to avoid; and annoyance, as a state of affairs which is avoided or from which escape is sought (29*a*).

The law of effect. The important thing for learning appears to be the *effect* or consequence of an act. This result may be pleasant, affectively indifferent, or unpleasant. It may be words of praise or condemnation from another person, the sensory cue for the next move, the perception of an error, the belief that a better method of attack may be found, or the conviction that one has reached the limit of his ability to improve. The "law of effect" has been considered for many years one of the foremost laws of learning. In general, according to this law as usually stated, a functional tendency or "connection" is strengthened when an activity is accompanied or followed by a "satisfying state of affairs," and weakened when the consequences are annoying (30). There has been considerable speculation and difference of opinion about how the aftereffect operates to alter the tendency governing an activity or response. But with respect to the observed relationships between outcome and elimination or fixation there is substantial agreement (7, 11, 12, 21, 31, 34).

On the basis of extensive studies on this problem, Thorndike holds that a satisfying aftereffect acts directly on a connection to make it stronger (29*b*). He feels, however, that the weakening influence of an annoying aftereffect is not so clearly indicated by experimental data. In one of his experiments in which the subjects were told "Right" when their response was correct and "Wrong" when the response was incorrect, he observed that the announcement of "Right" strengthened a connection it followed more than the announcement of "Wrong" weakened the one it followed. He concluded that annoyance does not have the direct and uniform effect in weakening a connection that satisfaction has in strengthening one. What takes place in the case of annoying outcomes, he believes, is the displacement or nullification of the responses that lead to annoyance by responses that are followed by satisfying results (29*c*).

The following observations appear to be in accord with this view (10). A cat had been trained to run to a box for food at the ringing of a bell. After the cat had done this many times and the habit appeared well established, equipment was added to the apparatus so that as she entered the food compartment, the cat received an electric shock. Upon being shocked the first time the animal backed quickly from the compartment and stood looking at the food but not venturing toward it. Here, apparently, there was a conflict of motives. The disposition to approach the food was checked by the counterimpulse to avoid the annoying shock. Due to this conflict the cat did nothing for a time. Finally she walked slowly away. After a few repetitions of the shock she responded to the bell, not by running to the box, but by walking to other parts of the room. The cat's first training had developed the habit of responding to the bell by running to the box and entering the food compartment. But the shock developed an avoidance set incompatible with the habit. The avoidance set, judging by the cat's behavior, was the stronger. Hence, the avoidance activity replaced the approaching-and-eating activity.

The relation of set to satisfaction and annoyance. When an individual has an urge, a habit, a task, an ideal, or is otherwise set toward a goal, he normally finds satisfaction in a performance that brings him to the realization of that goal. To act without interference according to habit and to accomplish one's purpose is satisfying. But to be prevented from reaching a goal toward which one is motivated is annoying. Frustration of purposes, interference with habitual modes of doing things, or violation of one's ideals produces stresses of an uncomfortable sort. To get on the wrong track when trying to reach a goal is distressing, but the fact that one is striving for the goal is what brings him back to the right track. Thus, proper motivation is fundamental to successful learning. With adequate motivation, successful learning is satisfying, and things that keep an individual from reaching his goal or retard his progress toward it, whether mistakes, false motions, needless detours, or barriers, fail to reduce the tensions of an unfulfilled motive and may increase them.

In an experiment where the learner is set to pick the right one of five words, the announcement "Wrong" by the experimenter serves to indicate that the learner has entered a "blind alley," that he has not reached his goal which is each time to select the right word. Here the annoyance at "Wrong" is intrinsically related to the motive. It is due to the individual's failure to achieve the goal toward which he is set. Since, as Thorndike found, "Right" for correct responses is more effective than "Wrong" for incorrect responses, it appears that in teaching, the emphasis should be more often positive than negative. If we can sufficiently motivate the desired responses, the undesirable ones will disappear because of their incongruity with the learner's goal. We should strive to establish suitable goals, for the goal set and goal striving will impel the learner to successful achievement and will lead to the abandonment of errors and ineffective responses.

The well-motivated learner not only strives for his goal but he endeavors to reach it in the most direct manner with the least possible expenditure of effort and time. This makes for improvement of performance. The cat mentioned in the previous chapter succeeded during the early stages of learning in escaping from the puzzle box and obtained food by the crude method of walking backwards and stepping by accident on the slat that opened the door of the cage. Despite repetition of this performance and its success as a means of escape, this method was later abandoned for the more direct and efficient one of pressing down upon the slat with a front paw. In another case a cat first succeeded in opening the cage several times by throwing herself down and rolling onto the slat. Later she substituted the downward thrust of her right front paw.

The goal itself may be improvement of performance, as in the mirror-drawing experiment, where the learner is set by formal instructions to do his best in speed and accuracy. The subject is likely to be dissatisfied with his initial performance. He wants to improve and he dislikes making errors. He is annoyed when he gets "stuck" on a troublesome turn. Because of his desire to improve, he keeps striving for a better performance. As a result of his repeated efforts, by the fifteenth trial he usually makes few or no errors and traces the path in much less time than was required in the first trial. This improvement is satisfying because it is in accord with the motive.

Rewards and punishment. In the case of rewards and punishment, we frequently have outcomes or aftereffects that are not relevant to the motive responsible for the activity but that nevertheless serve to reinforce or eliminate an activity or response which they follow (33). Experiments with animals have shown that if a response made because of one motive is followed by an effect that satisfies some other motive, the effect, though irrelevant to the first motive, serves to reinforce the response. Thus, the scratching by a rat is relevant to irritation but not to escape or eating. Yet when rats were released from a problem box and rewarded by food following the activity of scratching, the tendency to scratch was reinforced by the reward. The rats thus rewarded learned to scratch as a means of escape (18). The strengthening effect of irrelevant satisfying aftereffects has also been experimentally demonstrated with human subjects (32). A considerable amount of learning appears to result from outcomes which are irrelevant to the motive prompting the activity. When a child completes his arithmetic assignment under motivation by a task, and then is rewarded for accuracy and neatness by a special privilege or honor, the satisfying effects of the reward will tend to reinforce his efforts to secure neatness and accuracy in his work.

When a child is promised a reward before his performance, such expected reward is an *incentive*. An incentive irrelevant to the performance is called an *artificial incentive*. An incentive is something that satisfies a motive, and an artificial incentive is one that appeals to some other motive than the task. It operates to reinforce the task. It may turn out that the reward itself becomes the main goal and the task is formulated and resolved as a means of attaining the reward rather than the satisfaction to be derived from the performance itself. Here lies the difficulty in too much reliance upon artificial incentives in the classroom. When they are no longer provided, there is danger of a breakdown of motivation due to the failure of the pupil to find sufficient satisfaction in his work itself to prompt him to carry it on without arbitrary rewards.

That punishment following responses to be eliminated hastens learning has been amply demonstrated by experiments with both animal and human subjects. In one experiment, for example, a pathway in which rats received an electric shock was eliminated first; next to be eliminated was one in which the rat was caught and held; and the last to be eliminated was a long roundabout pathway to food (17).

The effect of punishment appears to be less direct than that of reward. The rat enters a blind alley because of his food-seeking set. But when he receives a shock, he quickly retreats. The recoil due to the shock is a recoil from the blind-alley situation. The pathway becomes something to be avoided, not merely a place where no food is found. An avoidance set is added to the tendency to stop entering the alley merely because it does not lead to the food and fulfillment of the motive. Hence, we observe a more rapid elimination of false runs when punishment is attached to them.

In a study with adult human subjects one experimenter used a maze so constructed that a shock was received at the end of blind alleys. A group who received the shock for errors learned the maze with fewer trials, in less time, and with fewer errors than another group who learned without punishment for errors. Shock for errors increased the time per trial, indicating greater caution, but since fewer trials were necessary to reach the criterion of learning because of the smaller number of errors, the total time required was less than for learning without the shock (3).

Other experiments have shown the accelerating effect of shock for errors in maze learning, in mirror drawing, and in rational learning (4). When the number of trials is constant, the total time is usually increased by shocks for errors while the errors are usually reduced. One investigator found in a mirror-drawing experiment that shocks for errors on one side of the path reduced errors on the other side where shocks were not received, due presumably to the greater caution induced by the shocks (1).

In the realm of human conduct the pattern of motives is often complex and conflicting. Here the influence of reward and punishment may sometimes extend over rather long intervals of time by means of memory and imagination. Punishment promised or foreseen on the basis of the consequences of one's own previous behavior, or consequences known to have been suffered by others for certain deeds may influence one's choices or his formulation of a task with respect to a certain action. The individual knowing or fearing that the outcome will be annoying may decide to refrain from a particular course of action or alter it in order to avoid the unhappy consequences. Here, of course, a conflict may arise. The individual may wish to avoid punishment, but at the same time he may value certain other fruits of his projected exploit so highly that he will go ahead with the conviction that the satisfactions to be derived will outweigh the possible or inevitable suffering. Then it is that punishment fails as a deterrent.

In this discussion, we have referred to experiments where shock for errors has been employed as punishment, and the punishment value of the shock has been taken for granted because it normally produces avoidance or withdrawal behavior. There have been, however, a number of experiments where shock has been administered for correct responses. Interestingly enough, this also has been found to facilitate learning (24). Muenzinger found that in the case of rats, shock for correct responses facilitated learning almost as much as shock for wrong responses. He concluded that a moderate shock made the animals more alert to the significant cues and that it did not serve to inhibit the response it followed (22). Results from an experiment by the same author with human subjects in which a punchboard maze was used showed no significant differences between those shocked for right responses, those shocked for wrong responses, and those who were not shocked. The writer attributed the failure of shock to produce acceleration to the fact that the subjects were fully motivated without shock and that its use could add nothing in the way of motivating effect (23).

It is believed that the accelerating effect of shock for correct responses may be due to its value as an indicator to the learner that his response is right and, therefore, in accord with his prevailing motivation. It tells him he is doing the right thing to reach his goal. It is likely that some, though not all, of the accelerating effects of punishment for wrong responses are due, likewise, to its value for informing the subject that he is missing his mark.

It should be noted in this connection, however, that while shock is regarded as a punishment, it is not a violent form of punishment. It is not to be concluded from these experiments that corporal punishment is a desirable means of motivation for the classroom. The shocks used are comparatively mild ones. Intense shocks have a deleterious effect. They tend to disrupt the learner's task, and inhibit the learning activity. If punishment arouses fear of the learning situation, it may make the learner more concerned with avoiding the discomfort than with his achievement as a learner. It may cause him to stop trying to achieve.

MOTIVATION OF LEARNING IN THE CLASSROOM

The problem of motivation. The success of any teacher depends upon his ability to secure learning activity which produces the desired results. To secure the appropriate activity the teacher must arouse and enlist effective motives. In the foregoing sections we have considered some of the fundamental features of motivation as revealed by laboratory experiments. A knowledge of these basic features should help us in understanding the problem of motivation in general. It should be distinctly borne in mind, however, that these studies do not and are not intended to provide us with techniques of teaching. There are certain important differences between the laboratory situation and the classroom. The subject in a laboratory experiment on learning is, for example, usually more highly motivated than the child or student in the classroom. The more rigid control of conditions in the laboratory makes it possible to isolate, at least approximately, the influence of various motivating conditions. The situation here is an artificial one compared to the classroom. In the laboratory, particularly in animal experiments, the motives are for the most part simple and basic, while in the classroom the teacher is confronted by a complex of motives, unique to each child, built up by experience under the pressures and channelizing influences of our modern civilized culture. Motivation here is an individual matter demanding resourcefulness and an understanding of the child's nature, his needs, and the various controls of human activity.

An incentive successful with one child may fail with another, and a device that worked well in the hands of one teacher will not always succeed when employed by another in a different situation. The value of any incentive or device for motivation depends upon all the factors in a particular situation, including the motives already possessed by each child (36). Motivation of classroom learning, then, is a problem each teacher must solve for himself. The knowledge derived from experiments and the experiences of other teachers is not the solution of this problem, but if properly used it should guide the teacher in working out his own solutions.

It follows then that specific rules for motivation are of limited value. No attempt is made here to prescribe panaceas to be used by the teacher who is able to secure only perfunctory effort from his class. The aim of the following paragraphs is rather to point out certain general procedures for securing earnest effort suggested by the studies of motivation. Five ways of motivating learning are considered. They are not mutually exclusive. They all may, and should so far as possible, be used together.

1. **Creating the desire for the outcomes of learning.** The best motive for learning is a strong desire for the outcomes of learning. It is natural; it gives significance to the task; and it is effective for securing diligent application of effort. Fortunately, such a desire does not always depend on the teacher. Children are eager to learn when they value the results to be obtained. The boy who wants to be able to

drive the family car does not have to be bribed to take driving lessons. Some students have so strong a desire for professional training and success that they are not only willing to study hard to that end but endure privations and hardships for the privilege of doing so.

If, however, there is no appreciation of the value of the learning outcomes, there will be no urge to work for them. It then becomes necessary for the teacher to do something more than assign lessons. The principal reason why children are not so eager to learn their school lessons as they are to learn to ride a bicycle, drive a car, or skate is that they value the abilities to ride, drive, and skate more highly than they do the abilities to be derived from their schoolwork. We are moved to work for the things we value, and we value those things which promise satisfactions or the avoidance of annoyances.

When the pupil does not appreciate the value the mastery of his lessons will have for him, the teacher should endeavor to secure such an appreciation by pointing out in a convincing manner the benefits and advantages to be derived from the results of his work. The child should be made to feel that in doing his lessons he is serving his own best interests. His work becomes significant and worth doing when he sees how the abilities derived from such work by others has benefited them, how such abilities are used to advantage in everyday life, and how they may be made to contribute to his own welfare.

In addition to desiring the outcomes of the learning activities, if the pupil is to devote himself wholeheartedly to the work assigned, he must have confidence in the teacher's wisdom in selecting and designing such exercises as will yield those abilities he desires. The student may desire to become a good surgeon, lawyer, nurse, or teacher, and be willing to work hard on those assignments he believes will help him realize his goal, but be utterly unwilling or reluctant to learn things he believes will contribute nothing to his acquisition of the abilities he appreciates and wants. The teacher should be sure first that the exercises or work he assigns will actually provide the appropriate learning activity, and then inspire confidence in the learner that by doing the work he will be taking a step nearer to his goal of achievement.

2. The enlistment of motives already present. Sometimes the value of the outcome as seen by the teacher is so remote in time from the work a child is called upon to do that he is unable to appreciate it sufficiently to give "voltage" to his work. Young children particularly need to have rather immediate goals. Older students can more easily be motivated by remote goals. When it is difficult to secure the appreciation of intrinsic values of the work because the benefits may be received only after many months or years, or where the learner is incapable of comprehending the significance of the work for his own future welfare for any other reason, the teacher may well enlist the impelling power of the many fundamental motives or desires which are found in every child to stimulate and concentrate effort on the exercises assigned (35).

There are certain basic needs that every child has. While these are highly socialized, they have their roots in the primary biological urges. Among these are the need for security, companionship, social approval, affection, recognition, new experiences, activity, and self-esteem. Schoolwork will be motivated when it is made to satisfy any of these needs. Practices that appeal to these motives include the use of games, special privileges, honors, praise when deserved, sympathetic help when needed, and assurance of ability to do the work. Older students will value and strive for such symbolic evidences of approval and success as good grades, promotions, college degrees, and membership in honor societies. Although these satisfactions are not derived from the intrinsic values of the learning outcomes, nevertheless, in being attached to these outcomes, they do promote the learning that leads to them. It is a case of adding other motivating conditions to those involved in the task itself. The task is reïnforced by the enlistment of other motives.

The use of incentives. An inducement to work which provides satisfactions extrinsic to the task is called an *artificial incentive.* Thus, a teacher stimulates her pupils to study their spelling by putting a rubber-stamp impression of the figure of a brownie on all papers having no words misspelled; another places names on an honor list as a reward for good work; another places specimens of good work on a bulletin board; another uses praise and reprimands; while others bestow upon the tractable and conscientious worker certain privileges such as doing errands, cleaning the blackboard, or emptying the wastebasket. It is not the thing itself that matters so much as its social significance. To sit next to the teacher may serve as either a reward or punishment according to whether it means honor or disgrace. Thus, a device that works well as an incentive in one situation may fail in others where its meaning is different. How it works depends upon how it is regarded by the pupils and whether it appeals to and satisfies a motive. The announcement "Right" for correct responses, and "Wrong" for incorrect ones will have little or no effect on learning apart from the desire for a correct performance. If the individual does not care whether he is right or wrong, being told so will not stimulate him to learn. To be effective, an incentive must appeal to a motive.

The successful use of incentives requires an understanding of human nature in general and especially of what children value. Poor judgment in this respect may do more harm than good. The following incident will illustrate this point. A young boy in the third grade came home from school and in a disgusted tone of voice said to his mother, "What do you suppose our teacher did today? Well, when we got all our problems right, she had us come up to the front of the room and then she squeezed a little rubber ball and sprayed perfume on us. The girls thought it was nice, but the boys thought it was sissy. At recess I went to the basement and wet some toilet paper and tried to rub mine off. The boys have decided not to get all their problems right so they won't have to have that stuff sprayed on them." Here even the honor value of the perfume spray could not overcome the traditional antipathy of the boys for anything "sissy." What is a value for one may be a source of annoyance to another. Values not only differ as between boys and girls, but also with age, and with different home and community conditions. In selecting incentives that will prove successful, the teacher must know what things children value.

Praise and reproof. Praise as an incentive usually appeals to the desire for approval. Reproof means disapproval, which is normally shunned. As a usual thing the former is satisfying, the latter annoying. But it does not follow that they will always produce these effects. Either may lose its effect by repetition, or either may under certain conditions produce exactly the opposite effect. Since it appears from experimental evidence that a satisfying outcome strengthens a tendency more than an annoying one weakens it, we may expect praise to be more effective under the general run of conditions than reproof. There are studies indicating this to be the case although in others there has seemed to be little or no difference between praise and reproof as incentives.

In a significant attack on this problem Hurlock (15) used four different groups all doing the same work in arithmetic. One group was praised for the improvement they had made and encouraged to do better, another was reproved before other pupils for their many careless mistakes and the inferior quality of their work, while a third group was ignored in that nothing was said about their work although they heard the remarks made to the others. A control group worked in another room and under usual conditions. The experiment covered a week's time. All three experimental groups did better than the controls. The praised and reproved groups both improved considerably on the second day but from then on while the praised group continued to improve, the work of the reproved group declined. The work of the ignored group was not so good as that of the reproved group. It appeared from the results that, under the conditions of this experiment, praise and reproof were both provocative of better work than no praise or reproof, that both incentives were about equally effective at first, but that praise continued as an effective incentive while reproof soon lost its effectiveness. While for all pupils combined, praise proved to be a better incentive than reproof, the difference was not the same for all types of students. Girls, for example, responded to praise more than boys. The latter appeared to be more stimulated by reproof. The duller children seemed to be moved most by praise, while the intellectually superior appeared to be least stimulated by this incentive.

Knowledge of results as an incentive. There is a considerable amount of experimental evidence that indicates the stimulating value of the learner's knowledge of his score, his successes and errors, and the progress he is making (14). There is satisfaction in bettering one's previous score, in seeing the errors disappear, and in watching one's curve of accomplishment rise to new heights—that is, of course, if one is trying to improve. Pointing out to a child his errors or other deficiencies in his work is the classroom analogue of the laboratory announcement of "Wrong" for incorrect responses or electric shock at the end of a blind alley. Through their informative value they both accelerate learning. Likewise, being informed of the good points in his work and the gains he has made is for the pupil what a mild shock or "Right" for correct responses is for the laboratory subject. The critical evaluation of a pupil's work will be more effective as an incentive to improvement when it is specific with respect to particular defects, errors, and good points than when it is general and indefinite, as in such comments as "Your work is poor," or "That is very good."

Emulation, competition, and rivalry. To *emulate* means to strive to equal or excel another person. The ambition or desire to do as well as, or outdo, other members of the group is one of the strongest motives for a pupil to do his best. It is a good motive to enlist if safeguards are employed to prevent it from arousing envy, jealousy, and animosity. Children usually have a strong desire to do what they see other children doing. They will normally work hard to develop the skills necessary to satisfy this desire. Emulation is aroused by the use of grades and letting each child see the kind of work the better pupils are doing.

Competition connotes a struggle or contest between two or more persons for the same object of desire. A competitive situation often stirs one to exert himself to the utmost. Many a teacher has been able to secure enthusiastic effort by means of a competitive enterprise when other methods of motivation have failed. For such motivation to be effective, a child must have a fair chance of winning. If a child knows from repeated experiences that he does not have a chance, he not only will not be stimulated to exert himself, but he may develop an attitude of hopelessness and a sense of inferiority or a resentment against the whole classroom situation. While generally considered more desirable from the standpoint of wholesome social attitudes, group competition appears to be less effective as an incentive than individual competition (19, 25).

The term *rivalry* is commonly used as a synonym for either competition or emulation, though sometimes it suggests more a personal contest for selfish ends tinged with jealousy and envy. That rivalry is an incentive to effort is quite clear. In one of the best experimental studies on its use, 155 fourth- and sixth-grade pupils were divided into two approximately equivalent groups for each grade on the basis of initial ability, sex, and age. The experimental group then was divided into two subgroups who were told that they were to try to surpass each other. The work consisted of addition exercises in arithmetic. Rivalry was further stimulated between the two subdivisions of the experimental group by putting the scores of each on the board, and calling out the names of the members of the winning group. This procedure was continued over a period of one week. The results indicated clearly that the rivalry had been a strong incentive, for the experimental group made considerably higher scores than the controls. Here the effect of rivalry was greater for the younger children, and for those less gifted intellectually (16).

The use of organized competition and rivalry in the classroom, while it no doubt does provide a strong incentive, is not generally regarded as a first-rate teaching procedure. It may work when other and better means fail. But it has numerous disadvantages. Aside from the fact that it is conducive to antagonisms and other undesirable social attitudes, it is probably the most artificial of artificial incentives. The interest is in beating the other fellow or the other group, not in the studies or in improvement. When the competitive conditions are removed, there is little likelihood of any transfer of interest or continuance of effort thus artificially aroused. A case in point is that of a teacher whose pupils had been coming to school without being properly washed. Urging and coaxing had failed to secure the desired handwashing. So she arranged for competition between boys and girls. Boys were lined up in one row, girls in another. Hands were held out as the teacher walked down the rows to see whether boys or girls had the cleaner hands. After a time the practice was discontinued. Then one morning one of these boys started off to school without his usual washing of hands and face. His mother caught him just in time and said, "Here, you haven't washed up yet." "Oh, we don't have to wash any more," was the youngster's reply.

Sarcasm, ridicule, and fear of punishment. The merits of any incentive must be judged by its effect on the pupil as well as on his effort. No pupil should be shamed or humiliated before his fellows. Sarcasm and ridicule are the devices of a weak teacher. They may have their place, but that place is not in the classroom. They breed attitudes of contempt, antagonism, and resentment, and these attitudes are not conducive to learning. They may impair the mental health of a timid or nervous child.

Fear of punishment and fear of failure are unwholesome for the child's emotional adjustment and their effect on learning is deleterious and inhibitory. A child needs security and self-confidence in order to make satisfactory progress. Punishment may be necessary in some cases of persistent misconduct but the threat of it should never be used to stimulate learning.

3. **Engendering favorable attitudes.** The nature and potent influence of attitudes have been presented above. Since these generalized sets have such an important influence on a child's work, it follows that attitudes favorable to learning should be built up and unfavorable ones removed. The teacher should endeavor to remove or prevent such negative attitudes as: fear of failure, discouragement, resentment toward the teacher, feelings of inferiority, indifference, feelings of insecurity, antagonism, and cynicism. On the other hand, effort should be made to promote self-confidence, self-reliance, a sense of security, a sense of belonging to the group, coöperativeness, respect for the teacher and good scholarship, and the feeling that school is a privilege. The following cases illustrate the potency of attitudes as factors in motivation.

Harold, age nine years ten months, I.Q. 160, was referred by a child guidance clinic for remedial instruction. He was failing in the fifth grade. A standardized achievement test placed him at the third-grade level in history and geography, and low third grade in spelling and arithmetic. Since he was lower in spelling and arithmetic, his instructors concentrated on these subjects during five weeks with only the usual instruction in the social studies. At the end of the five weeks another form of the same achievement test was given and this showed an advance to the sixth-grade level in both geography and history. Was it three years' work in five weeks? Probably not. A more plausible explanation is found in the change in the boy's attitude toward his schoolwork. His instructors cleverly built up confidence and enthusiasm. They taught him to like his work and made him eager to show how well he could do. During the first test he worked in a half-hearted manner, and spent considerable time gazing about the room, though urged to do his best. In the second test he applied himself earnestly and vigorously. The boy did not show his real ability in the first test because he disliked schoolwork and that included the taking of tests.

Donald had made good progress in the elementary school, but when he went to junior high school, his work slumped badly. His father talked with the teacher, who told him his son was not capable of doing the work she demanded. The boy felt that his teacher thought he was dumb. Donald was saved, however, by a fortunate turn of events. The teacher organized an activity-unit centered around some of the large universities. The children were divided into groups, one for each of the selected schools. It fell to Donald to secure a banner for his group which represented a university on the west coast. He was puzzled about how to get a banner of this famous school so far away. Finally, at the suggestion of his father he wrote to the president of the university, telling him about their school project and asking him if he would not supply a banner for his group. The boy not only received the banner but also a friendly letter from the president. He proudly took the banner and the letter to school and there received the admiring attention and applause of his classmates and the hearty commendation of his teacher. He felt important; he had won recognition and prestige. From that moment on his schoolwork was excellent.

Interest. Interest is an attitude which is not only favorable to learning but is essential to a high level of work and accomplishment. Like other attitudes it serves to direct and sustain attention, and to focus and energize action. In the school, it is usually secured by making the work significant and vital to the child or by relating the work to certain interests which he has already developed. Actually, the arousal and utilization of interest involve the appeal to the basic needs of children and other desires or motives they may have at the moment, such as have been considered in the preceding paragraphs. A child or adult is normally interested in things that satisfy or promise to satisfy his wants and wishes. The adventure story is interesting because it appeals to the natural desire for new experiences and action. Competition appeals to the desire for ascendance. Honors cater to the desire for prestige, recognition, and self-esteem. Games provide companionship and satisfy the gregarious tendencies. One tends to be interested in those things which relate to his personal security and welfare.

Interest is also related to one's past experiences and abilities already developed. The picture of an acquaintance in the newspaper, or a news item from the home town arouses a surge of interest. One finds the game of bridge an interesting pastime if he can play it well. Baseball may be very interesting to the fan who knows about the teams but not to the uninformed. We are not likely to be interested in things that do not concern us personally and concerning which we are ignorant. Interest in such subjects as literature, music, engineering, history, mathematics, and the various sciences is something that is developed as one finds satisfying experiences in the study of them. The student who announces his lack of interest in a new subject after his first or second lesson may be telling the truth, but it is unfortunate if he decides then that there is no possibility of interest for him in that field. Education can and should enlarge the range of our interests and thus add to the rich and satisfying experiences of life.

The skillful teacher will be alert to the interests which his pupils already have and will enlist these interests to stimulate learning. One teacher of a boy who would never study his lessons walked by his seat one day and noticed that he was spending his time drawing pictures. Instead of scolding him for wasting his time, she picked up some of the boy's drawings and exclaimed, "Why, Nelson, these are beautiful. I didn't know you could draw so well. Won't you draw some pictures to illustrate the lesson for the class?" The boy was delighted with the teacher's reaction to his hobby and agreed to do as she suggested. But to illustrate the lesson he had to study it. Commendation for his illustrations and the interest shown in them by the other children soon made Nelson a diligent pupil. Cartoonist George Clark presents the point well in a drawing that shows a classroom with boys working earnestly and a teacher telling her principal that the boys had become "positively brilliant in arithmetic" since she "changed the problems from apples to airplanes" (9). Interests centered around special days, such as Thanksgiving or Easter, or the current enthusiasm aroused by the exploits of a national hero can be used to stimulate learning through the medium of suitably organized activity units. This is being done today in some of our better schools with excellent results.

Play. As stated earlier, interest may be centered in the learning activity itself, or in the results of the activity. When an activity brings its own satisfaction and is engaged in for its own sake, we call it *play.*

Work is activity in which one engages for results which bring satisfactions. A man is fortunate if his work (means of earning a livelihood) is play to the extent that he enjoys it. Many of the most worthwhile accomplishments of the race have been achieved through activity infused with the spirit of play. The clever teacher utilizes the natural love of children for play to promote their learning. Games can be educational as well as entertaining. For younger pupils the practices that make the learning itself a happy experience are most desirable. As the child advances toward maturity, however, he must, if he is to be truly prepared for life, learn to work for ultimate and remote outcomes. He must learn the art of persistence under unpleasant circumstances and achieve the ability to forego present satisfactions for the sake of greater future values. To this end, the child must be trained to center his interests in the future returns of his efforts.

4. **Fostering the development of ideals.** Since ideals, like attitudes, are generalized controls of activity, they may be expected to promote learning, in so far as they are developed and brought to bear on classroom and home study. The prompting influences and normative regulation of conduct provided by such ideals as honesty, courtesy, neatness, accuracy, industry, open-mindedness, generosity, and respect for others may be made to serve as important motivating factors in the classroom as well as in other life situations. The problem of securing effective effort on the part of pupils will be simplified considerably if the teacher can instill such ideals and bring the work of the classroom within their sphere of influence.

5. **Establishing tasks and problems.** While the motivating factors discussed in the preceding paragraphs determine largely the energy and enthusiasm with which a pupil applies himself to his work, it is the task that primarily determines the specific form of the activity undertaken at a given moment. Although the source of the classroom task of the child may be and frequently is found in occasional or self-instruction, the main consideration here will be the prescriptions or assignments of the teacher as the instigator of successful learning. When the morale of the classroom is good, a child will ordinarily do as he is told. To be effective, the exercises devised and assigned must be such that the activity they incite will produce the skills or knowledge the teacher wants his pupils to acquire. They must be consistent with the ability level of the pupil, and the instructions for doing them must be clear, definite, and understandable. They commonly include such matters as reading certain pages, writing themes, doing examples in arithmetic, memorizing poems, studying the spelling of specified

words, making reports, keeping notebooks, reciting material studied, and performing laboratory experiments. The subjective nature of the task is to be kept in mind. The task is not the assignment made by the teacher, but the child's own formulated purpose or intent. Even when the assignment is well made, from the teacher's point of view, if the child does not hear it or fails to understand it correctly, the desired activity will not be forthcoming because of the lack of the proper motivating set.

It should be remembered also that there are age differences with respect to the complexity of a task that may be formulated and sustained until the appropriate action is completed. In the new Stanford-Binet tests, for example, the "three commissions" test is placed in the second half of the fourth year (28). The child is told in this test to do three things, such as placing a pencil on a certain chair, opening a door, and bringing to the examiner a designated box. Thus, a child of average mentality at this age level may be expected to formulate and complete a task involving three definite steps. Children below this age will require simpler instructions, while older ones may be expected to have greater ability in this direction.

Summary of the Chapter

The activities of an individual are initiated and governed by many factors, important among which are sets or motives. The principal motives are physical needs, habit, desire for companionship and social approval, attitudes, the task, the problem, and ideals. The sources of the task and problem are self-instruction, occasional instruction, and instructions given by another person. When several motives are present, we may have mutual reinforcement and conflicts between them.

The effect of any function has an important bearing on its elimination or fixation. According to the law of effect, a satisfying outcome or aftereffect strengthens a tendency, while an annoying aftereffect tends to weaken it.

Activity in accord with one's motives is normally satisfying, while frustration or interference with such activity is usually annoying. But aftereffects not relevant to the motive also promote learning. This is seen in the influence of rewards and punishment.

There is no simple rule or best procedure for securing classroom motivation. The value of any device depends upon all the factors in the particular situation, including the motives already present. The forms of motivating procedures discussed are: first, arousing desire for the outcomes of learning; second, enlistment of motives already present by the use of suitable incentives; third, engendering favorable attitudes and eliminating unfavorable ones; fourth, fostering the development of ideals conducive to diligent work; and fifth, establishing tasks and problems.

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Chapter VII

CONDITIONING

The principle of conditioning. *A functional tendency may be modified so that the individual will respond to a given stimulus-situation in a new way if there is added to that situation during the period of learning a stimulus-factor adequate to produce the new form of response.*

Through learning we develop tendencies to react to situations in new ways. But we learn by reacting to situations, and the reactions through which learning takes place are restricted to those tendencies we already possess. How then, one may ask, is it possible to acquire a wholly different mode of reacting to a situation? To put the question in concrete form: how can a child who has never responded to the sight of

$$3 \times 4 =$$

by saying, "Twelve," develop the tendency to do so? When the teacher first shows him

$$3 \times 4 =,$$

he may look at it, wrinkle his brow, squirm in his chair, say, "Three and four," or do something else; but he does not say, "Twelve." If the teacher wants him to learn to say, "Twelve" in response to seeing this combination in print, it will be necessary to present *with*

$$3 \times 4 =$$

stimulus-conditions which will evoke that response. There are in this case several possibilities. The teacher may say, "Twelve" and have the child repeat the word, or he may show a card on which the number *12* appears along with

$$3 \times 4 =.$$

Let us assume that he uses the former procedure. He points to

$$3 \times 4 =$$

and then says, "Twelve." The child at first says, "Twelve" because that is what he *heard*. But each time he hears "twelve" he *also sees*

$$3 \times 4 =.$$

After a few repetitions, when he is shown

$$3 \times 4 =,$$

he says, "Twelve" at once without waiting for the teacher to say it. Thus, a new functional tendency is developed, and the child now responds to the sight of

$$3 \times 4 =$$

in a wholly different manner than he did before it was associated with his hearing "twelve." The situation (sight of

$$3 \times 4 =)$$

was first modified by including the spoken word as the stimulus-factor needed to elicit the desired response. Then after the response was made a few times to the new total situation, the spoken word was eliminated, but the child continued to say, "Twelve" in response to the sight of

$$3 \times 4 =.$$

The latter phase of this process is a matter of *cue-reduction* described in chapter II. Such is the process of learning called *conditioning.* It is a fundamental means for developing new functional tendencies and for acquiring new modes of reacting to situations.

The conditioned reflex. While it had been known for a long time that a stimulating situation tends to take on the role of initiating a different activity as a result of its association with some stimulus-pattern or agent already effective for arousing this activity (35, 40, 62), it was not seen that this principle of modification applied to the reflex responses until about the beginning of this century. This discovery is attributed to three investigators: I. P. Pavlov (1849–1936), a Russian physiologist; V. M. Bechterev (1857–1927), a Russian neurologist; and E. B. Twitmyer (1873–1943), a psychologist at the University of Pennsylvania. These investigators came upon it independently and at about the same time (71).

Pavlov was conducting experiments on the physiology of the digestive process in dogs in his laboratory in Russia when he noticed that there was a flow of saliva in a dog's mouth before the animal was actually given food. This secretion of saliva appeared when the dog saw the food or the attendant who usually fed the dog, or even when the dog heard the attendant's footsteps in another room. To Pavlov this was a highly significant phenomenon. Food in the mouth, it appeared, was the natural stimulus for arousing activity of the salivary glands, but not the sight of a particular man or the sound of his footsteps. The fact that now these new stimuli aroused the secretory reflex must be due, he believed, to the conditions of the experiment and associations built up by them. Here was learning in its most primitive form, the first step away from purely inherited behavior to learned behavior.

This reflex response to a new and artificial stimulus was called a *conditioned reflex.* Pavlov saw it as the key to the understanding of the development of all adaptive behavior. He proceeded to organize and conduct many carefully controlled experiments on the conditioning of this reflex in the hope of discovering the secrets of brain physiology.

Pavlov's early experimental studies. In order to study the action of the salivary glands more exactly, an arrangement was made to measure the amount of saliva secreted under controlled stimulating conditions. The dog was first placed on a table in a restraining harness, and then food was presented. At the same time another, or secondary stimulus, such as the sound of a bell, was presented. At first the bell alone did not cause the salivary response; but usually after twenty to forty presentations with food it aroused the flow of saliva even when not accompanied by food. The bell then had become a "conditioned stimulus" (CS). The originally adequate stimulus (in this case food) was called the "unconditioned stimulus" (UCS), and the salivary response to the bell was called a "conditioned reflex" (CR). In these experiments, this secretory reflex was conditioned to many different stimuli, such as the sound of metronome beats, the odor of camphor, the sight of letters and geometrical designs, and cutaneous contacts. It was believed possible to attach the response to any form of stimulation under the appropriate conditions. Pavlov worked for many years on the secretory reflexes and investigated in great detail many features of the process of conditioning.

The work and influence of Bechterev. In the meantime, Bechterev was working with dogs and also with human subjects. He studied the motor reflexes, using as the natural stimulus an electric shock. It was observed that with the application of this stimulus there occurred a sharp withdrawal of the stimulated member. He found that after a few applications of electric shock in conjunction with another stimulus, which at first was indifferent, the defensive movement appeared at the application of the associated stimulus without the electrical stimulation. Bechterev called this response to the originally indifferent stimulus an "associated reflex."

While Pavlov was interested in discovering the nature of brain activity and was quite indifferent to psychology, Bechterev was interested in creating an objective psychology. He made the reflex his basic concept and avoided the use of the concepts and terms of introspective psychology. His point of view coincided nicely with the growing behavioristic trend in this country. His writings had considerable influence on American psychological thought.

Twitmyer's demonstration. The first experimental demonstration of a conditioned reflex in man (10) is attributed to E. B. Twitmyer, an American psychologist (6). In 1902 this investigator was studying the effect of tensing the muscles upon the extent of the patellar reflex. A bell was used to signal the subject to clench his fists as the hammer for striking the patellar tendon was about to fall. One day, through some failure of the apparatus to function properly, the bell was rung but the hammer did not fall. In response to the bell, however, there occurred a kick even without the blow on the patellar tendon. (Recently a demonstration similar to this was made in the writer's laboratory.)

American interest in conditioning. Little attention was given to conditioning in America before 1915. In that year John B. Watson, leader of the behavioristic movement in this country, discussed "the place of the conditioned reflex in psychology" in his presidential address before the American Psychological Association (65). Pavlov himself had not been interested in psychology. He was desirous of discovering the secrets of the workings of the brain. He believed his methods provided an excellent means for exploring this field. Nevertheless, the technique of conditioning appealed to many psychologists as providing an objective approach to the study and understanding of human behavior. The behaviorists in particular seized upon the principle as the explanation of the process whereby all complex forms of behavior are elaborated from a limited number of simple original reflexes. After 1915 interest in conditioning developed rapidly and the subject began to receive a prominent place in textbooks on psychology (19*a*).

Pioneer experimental work on conditioning was done in this country by Watson, Mateer, and Cason. About 1915 Watson conditioned withdrawal reflexes of the foot and finger. His method was to administer an electric shock to the foot or finger and at about the same time ring a bell. The electric shock as the UCS produced a sharp withdrawal of the stimulated member. He found that generally after a number of trials with double stimulation, the bell alone was sufficient to produce this withdrawal response (66). He later extended his studies of conditioning to the fear responses of young children (67).

One of the earliest American studies was made by Florence Mateer (39) at Clark University. Krasnogorsky, a student of Pavlov, had investigated experimentally the conditioning of the salivary reflex in children. His method was similar to Pavlov's, except that instead of measuring the actual amount of saliva secreted, he recorded the number of swallowing reactions to determine the extent of the response. In

1914 and 1915 Mateer conducted an experiment, using a modified form of his method, on about fifty children ranging in age from one to seven years. Her procedure was to have the child lie down. Then a blindfold was slid over his eyes from above. After an interval of ten seconds a bit of sweet chocolate was placed in his mouth. At first swallowing and mouth opening occurred as an UCR to the chocolate; but after a number of trials, which varied for different children, mouth opening and swallowing occurred when the bandage was applied to the eyes and before the chocolate was presented. When this had occurred in two successive trials, the response was regarded as conditioned to the blindfold. As a pioneer study her work is important, for it demonstrated the possibilities of employing such a method to advantage in studying the development of behavior in young children.

Several experiments have been made on conditioning of eyelid closure and the pupillary reflexes. Cason (6) was the first to use these responses in a carefully controlled experiment. His experiments provide an excellent example of the techniques and results of conditioning. In his investigation of the pupillary reaction a change of light intensity served as the UCS for producing dilations or contractions of the pupils. A bell was used for the CS. In the case of four subjects the light was increased as the bell rang, with the result that after a few trials the sound of the bell, with no change in the light intensity, caused pupil contraction. Associating the bell with decreasing light conditioned four other subjects so that when the bell rang, their pupils dilated. One subject was trained so that when the bell rang, his pupils contracted; but when a buzzer was sounded, they dilated. Another subject learned to respond to an electric shock by a contraction of the pupil, and then after additional training with decreasing light, the shock produced pupil dilation in the same subject (4). In a later experiment Cason conditioned eyelid reflexes to a sound stimulus by presenting an electric-shock stimulus (UCS) in connection with a sound of low intensity (CS). He observed that the conditioned wink reflex was faster than voluntary winking (5).

These and other experiments on conditioning in this decade between 1915 and 1925 were concerned mainly with finding out whether various types of reflexes could be conditioned. That such was the case they clearly demonstrated, although some important questions were raised. Hamel (16), for example, made a study of the finger-withdrawal reflex, using a sound for the CS, and an electric shock for the UCS. He concluded from the objective evidence and introspective reports of his subjects that the conditioning of this withdrawal response in human subjects is complicated by voluntary processes and influenced by conscious factors.

In the meantime radical behaviorism, staking its claims on the speculative significance of conditioning, was gaining prestige in this country. Then in 1927 appeared a translation of Pavlov's book, *Conditioned Reflexes* (44). This book and his *Lectures on Conditioned Reflexes* (45), which followed shortly, made available to American psychologists the fruits of detailed and careful research which had been conducted by Pavlov and his co-workers for a quarter of a century on the salivary reflexes. The influence of this scholarly research was soon manifest in the psychological laboratories in this country.

While during the decade between 1930 and 1940 there was a decline in the theoretical emphasis on conditioning, there has been an extension of the discoveries of the Russian investigators and the accumulation of much detailed information concerning this elementary mode of learning. Broadly speaking, most of the findings of Pavlov have been verified, although some exceptions to his generalization have been found, and some of his interpretations have proved unsatisfactory (72*a*). Only a brief account of the outstanding features of conditioning as worked out by Pavlov and others can be given here. Those which have come to be rather generally recognized must be considered because of their importance to our subject.

Factors in the Establishment of Conditioning

Isolation of the conditioned stimulus. In Pavlov's early experiments it was found that the secretion of saliva appeared in response to various factors in the experimental situation besides the intended CS. It appeared at the sight of the dish in which food had been presented, at the sight of the attendant, and in response to being placed in the restraining harness, or to sounds from the street. It was necessary, therefore, to take special measures to confine the response to the particular agent selected to become the CS. In addition to the elaborate precautions used to avoid distracting stimuli, the dogs were given preliminary training to accustom them to standing on the table in the restraining harness, to the sight of the apparatus, and to other features of the experimental situation that were to remain constant during the experiments. This adaptation or habituation to the experimental situation apart from CS and food made it possible to avoid the association of these other factors with feeding and prevent them from becoming conditioned stimuli.

In Mateer's experiments, where the bandage was used as a CS for chewing and swallowing responses, it was found that lying down, or even entering the laboratory, was a conditioning factor. These and other incidental factors of the experimental situation had to be rendered ineffective through adaptation in order to restrict the CR to the bandage. To prevent lying down from becoming a CS, Mateer had the child lie down frequently during the intervals between experiments. At these times he was not given chocolate, nor was the bandage placed over his eyes (39*a*). Similar adaptive procedures served to differentiate the bandage stimulus from other aspects of the total situation.

Repetition in conditioning experiments. As in other kinds of learning, repetition is usually an important factor in conditioning. Repetition here means the repeated presentation of the CS and UCS together. The number of trials required to establish the degree of conditioning desired has been found to vary greatly with different types of procedures and for different subjects. Reports on the number of trials used in experiments vary from success after one paired stimulation to failure after several hundreds. It appears that conditioning is most often built up gradually, with each successive trial adding some increment of learning. The first trial apparently produces some effect, but in most cases it does not bring about a full overt response to the CS alone.

In a demonstration experiment by the writer of finger withdrawal with electric shock for the UCS and a buzzer for the CS, no response to the buzzer alone was observed after fourteen paired stimulations. After the two stimuli had been presented eleven more times, a slight movement was made in response to the buzzer, but the finger was not lifted from the electrode. Eight more paired stimulations were given and then the finger was fully withdrawn at the sound of the buzzer. But the CR was still unstable. It failed to appear in some of the later trials, and when it did appear, it varied from a barely noticeable twitch to full withdrawal. It required many additional trials after its first appearance to establish it to the criterion of three successive complete withdrawals.

More precise methods with suitable instruments have shown that in the earlier trials, before movement actually takes place, the CS produces certain activity within the muscles, which is too weak to produce movement (72*b*). This indicates that in conditioning, as in most other forms of learning, the process is one of gradually building up the new tendency. The early trials are adding their increments of learning effects even when these are not manifest in performance (18).

Distribution of repetitions. It has been found, moreover, that distributed repetitions are more effective than massed practice in experimental conditioning. The results of a given number of trials will be better if these trials are spaced or spread out than if they are crowded either by having them follow one another in rapid succession or by having them bunched in large numbers at a single session. Pavlov was careful to avoid crowding of practice in his experiments. Experimenting on rats, Schlosberg (59) secured conditioning in nine out of ten animals with twenty-five paired stimulations during each half-hour session, but when 200 double stimulations were given in a single session practically no conditioning was obtained.

In a study of eyelid responses in human subjects, using a shock as the UCS and a change in the brightness of a light as the CS, Calvin (2) found that conditioning was much more readily established when the interval between trials was twenty seconds than when it was 3½ seconds or 6⅔ seconds.

Humphreys (26, 27) also demonstrated the superiority of distributed practice in the establishment of the conditioned eyelid reaction. A light for the CS was followed by a puff of air to the eye for the UCS. One group of subjects was given paired stimulation every thirty seconds while the other one received the same stimulation once a minute. It was found that one trial a minute brought better results than two a minute and that forty-eight trials with interspersed rest periods were as good as ninety-six without rest periods. The results indicate a decided advantage in favor of the distribution of trials as against massed trials in this kind of learning.

The temporal relations of the CS and UCS. In our discussion so far, we have pointed out that conditioning results from combined stimulation by the unconditioned and conditioned stimuli. There are, however, a number of variations in temporal relations between the stimuli used in such paired stimulation.

Pavlov considered simultaneous stimulation basic to other methods. In practice, however, stimulation was considered simultaneous when the CS preceded the UCS from a fraction of a second up to five seconds. It was found that simultaneity was not only unnecessary, but that, usually, better results were obtained when the CS preceded the UCS by a fraction of a second. Longer intervals are less favorable.

Numerous attempts have been made to secure conditioning by having the CS come after the UCS. This is known as *backward conditioning*. The attempts to secure it have rarely been successful as it is established only with great difficulty and it tends to vanish quickly (17, 19*b*, 46, 70).

The influence of set in conditioning. Since conditioning, like other forms of learning, is accomplished through reacting to the stimulating situation, it is to be expected that drives, attitudes, and other forms of set will play an important role in the process. Experimental studies have shown this to be true.

In describing the salivary reactions of dogs to the sight of food, Pavlov (45*a*) states that when a dog is hungry his reaction is much greater than when he is satiated. Zener and McCurdy (73), who trained dogs to salivate in response to a light stimulus, found that as the degree of hunger was decreased, there was a decrease in the amount of conditioned secretion.

Grant (12) has shown that an expectant attentive set toward the CS greatly influences the conditioning of the eyelid response in human subjects. Two groups of subjects were conditioned, under different instructions, to react to light by winking. A puff of air to the eye served as the UCS. One group was instructed to maintain an active attitude of expectancy toward the light, while the other was told to look toward the source of the light but otherwise to take a passive attitude toward it. Conditioning took place more rapidly in the active-attitude group, and in this group the CR was more stable, generally greater in amplitude; and of shorter average latency than in the group that assumed the passive attitude.

In a similar experiment, Miller (41) found that conditioning of the eyelid response to light was influenced considerably by a facilitatory or inhibitory attitude on the part of the subjects. One group was instructed to inhibit the lid reflex. Another was told to refrain from any attempt to control the lid movements voluntarily. The second group conditioned more quickly than the first group. The evidence was to the effect that the conditioning of this response is retarded by an inhibitory attitude.

The influence of attitude and task in configural conditioning was studied by Razran (52). Red and green lights (CS) were flashed while the subjects were eating. One group merely chewed gum, sucked lollipops, or ate while the lights were flashed. Members of a second group were given the task of solving a bolthead maze while eating, and for them the lights were associated with food by using a red one to signal a wrong move and a green one to signal a right move. Salivary responses were conditioned in all subjects to both the pattern of lights and to individual components or single lights. But for the first group the pattern was more effective as a CS than the single lights, while for the second group the individual components of the pattern were more effective. Since the visual stimuli were alike for these groups it was concluded that the differences in the results were due to the different attitudes and task sets of the two groups. The maze task apparently directed attention toward single lights and favored conditioning to them individually. The first group, on the other hand, having no particular concern for the individual components of the light pattern, probably attended more fully to the combination or pattern of lights, thus assuming an attitude that favored conditioning to the pattern. This author concluded that for the patterning of conditioned behavior in human adults habits, attitudes, sets, and interests are more important than the sensory fields resulting from the stimulus-pattern.

Individual differences in conditioning. A fact of prime importance to the teacher is that individuals differ widely in the ease with which they learn. It is significant, therefore, that experiments reveal extensive individual differences with respect to the modification of even simple forms of behavior by conditioning. Pavlov found that some dogs were conditioned much more readily than others. He believed this was owing to the fact that dogs differed in their susceptibility to stimulation and inhibition. The American studies on conditioning have revealed important differences not only between animals of different species and age, but also between individuals of the same species and same age. Mateer found that younger children required more trials than older ones to condition the swallowing movements to the bandage placed over their eyes, and that feeble-minded children required many more trials than normal children.

Campbell and Hilgard (3) report wide individual differences in the ease with which the eyelid responses were conditioned in human subjects. Not one of sixty-three subjects failed to show at least one CR during a training series of 100 paired stimulations, which consisted of a flash of light of low intensity followed by a puff of air against the cornea. One subject failed to reach the requirement of five CR's for complete conditioning. For the sixty-two who reached the criterion the mean number of trials required was twenty-five, but there was a range of individual variations from seven to ninety trials.

The neural structures involved in conditioning. Many attempts have been made to determine what neural structures are essential for the establishment of a CR. A number of investigators have successfully conditioned responses in dogs from which part of the cortex was removed. In one study the removal of the visual cortex of dogs not only did not prevent conditioning of the eyelid response to light, but practically no difference was found between this conditioned response in normal animals and in those from which this part of the brain was removed (37).

Pavlov (45*b*) reported as unsuccessful a number of attempts to establish conditioning in animals deprived entirely of both cerebral hemispheres. These failures led him to believe that the cerebral cortex was essential for conditioning and for all learned behavior. In later experiments, however, it has been found possible to produce CR's in dogs and cats from which both hemispheres were removed. While the more recent evidence indicates that the cerebral cortex is not an absolute essential for the establishment of conditioning in lower animals, it appears that when both cerebral hemispheres are completely removed, the possibilities of conditioning are more limited than in normal animals. A longer period of training and more intense stimuli are required for such subcortical learning. It has been suggested that in the higher levels of the animal scale, learning may depend more upon an intact cerebral cortex (28, 19*c*).

A study by Culler and Mettler (8) revealed a significant difference between conditioning in normal and decorticate dogs, which suggests the importance of the cortex for the development of adaptive behavior. They found that normal dogs, when trained to lift the foot in response to auditory or visual stimuli to avoid shock, passed through two stages of conditioning. In the first stage these animals manifested a crude, diffuse form of behavior in response to the CS. Then as training continued, the diffuse behavior subsided in favor of a specific avoidance response of the leg. A dog from which the cortex was removed was conditioned to react by this crude form of behavior as readily as were the normal animals, but further training failed to differentiate the specific foot-lifting reaction. This animal deprived of a cortex could not pass to the more refined stage observed in the normal animals. The authors concluded "that the cortex is not at all needed for 'conditioning' as such in its most primitive and diffuse forms; but is definitely needed for an adaptive, problem-solving response."

Shurrager and Culler (60) have demonstrated that a CR can be established by the spinal cord when it is completely severed from the brain. A transection of the cord was made between the cervical and third lumbar spinal roots. In ninety-eight out of 219 spinal dogs CR's were elicited by combining mechanical or electric stimulation of the tail with shock to the left hind paw. Whereas at first there was contraction of the flexor muscle of the leg only when the shock was applied to the paw, after a number of combined stimulations this muscle responded when the stimulus was applied to the tail alone. Evidence obtained from severing various spinal roots indicated that the central locus of the modification responsible for conditioning was at the level of the spinal cord where the conditioned muscle was innervated. The experiments indicate that some conditioning can be accomplished even without the services of the centers in the brain stem.

Forms of Conditioning

"Reflexes of the second order." Pavlov (45*c*) showed that a CR may be conditioned to a new stimulus without the aid of the original UCS. A reflex is, as we have seen, conditioned to a secondary stimulus by associating the original stimulus with the secondary. Now if this secondary stimulus is repeatedly presented with a third, this third stimulus may become adequate for arousing the reflex response even though it has not been directly associated at any time with the primary stimulus. Pavlov called such reactions "reflexes of the second order."

In his demonstration of this form of conditioning the salivary reaction was first conditioned to a light stimulus. Next a tone was sounded with the presentation of the light. At first the salivary response was elicited by this combined stimulation though no food was presented. After a few such trials the light was omitted and the tone alone caused the salivary reaction. It was a weak response and very unstable. Yet it indicated that the tone had taken on the properties of a CS as a result of its occurrence with the light stimulus even though it had not been presented with food. Secondary conditioning is significant for the suggestion it offers as to the possibility of continuous modification of functions through the association of old with new stimulating conditions.

"Sensory pre-conditioning." In conditioning of the second order we have seen that if two stimuli are presented repeatedly, a response *previously* conditioned to one of them will be elicited by the other. But if two stimuli are presented together repeatedly, will a response *subsequently* conditioned to one of them also be aroused by the other? That this occurs, under some circumstances at least, has been demonstrated by Brogden (1). In his experiment eight dogs were given twenty successive combined stimulations a day for ten days with a bell and a flash of light. After the 200 light and bell trials, the animals were divided into two groups. One group was trained to respond to the bell with flexion of the left foreleg by combining the sound of the bell with an electric shock. The second group was in like manner trained to respond to the light by flexion. After this conditioning had been well established the bell-conditioned group was tested with the light alone, and the light-conditioned group was tested with the bell. Control animals, which had not been given the preliminary trials with light-bell combination, were conditioned in a similar way, one group to respond to light, another to the bell. It was found that the conditioning of one of these two stimuli had in most cases made the other one an effective signal for flexion in the case of the experimental groups but not in the case of the control animals. The pattern of learning demonstrated here is important for indicating one of the many ways in which the association of experiences contributes to the modification of behavior.

Configural conditioning. A number of experiments have shown that a response may be conditioned to patterns of simultaneous or successive stimuli, such as a combination of varied colored lights or a sequence of tones. Pavlov found that if a combination of stimuli is regularly reinforced by feeding, this pattern may be differentiated from other patterns not accompanied by feeding. The reinforced combination becomes an effective signal for eliciting the salivary secretion while other patterns of the same stimuli not accompanied by feeding remain or are rendered ineffective. In one of the early experiments from his laboratory various sequences of four tones were used. It was possible to arrange twenty-four different sequences of these tones. Only the arrangement in order of ascending pitch was accompanied by feeding. It was reported that this order was differentiated from all the other sequences. This meant that salivation occurred when the tones were presented in the ascending order, and that this response was not made when they were presented in any other sequence (44*a*).

According to Pavlov's results, if a combination of stimuli is made an effective signal for the arousal of the secretory response, the individual components of this pattern vary as to effectiveness when presented alone. Sometimes a single component was fully as effective as the combination while others were found to be wholly ineffective (44*b*).

Razran has made a number of studies of configural conditioning (50). In one of his experiments alternate flashings of red and green lights were used for the patterned stimuli, and similar flashings of two red, or two green, or single lights were employed for non-patterned stimuli. He reports unmistakable evidence of this form of conditioning (51).

Delayed conditioned reflex and trace reflex. In simultaneous conditioning, that is, where the CS precedes the UCS by an interval of time not longer than five seconds, the CR usually follows the CS almost at once. When, however, the onset of the CS precedes the UCS by intervals longer than five seconds, there tends to be a corresponding delay of the response after conditioning is accomplished. When such longer intervals are used and the CS continues until the UCS occurs, the result is called a *delayed conditioned response.*

It is difficult to establish delayed conditioning without first conditioning the response simultaneously. In developing a delayed CR, Pavlov first conditioned the response by having the UCS follow the conditioned stimulus by not more than five seconds. Then as training was continued, the interval of delay was increased by five seconds each day until the desired interval was attained (19*d*).

It is not necessary, however, that the CS continue until the arrival of the UCS. It may be presented for a few seconds and removed before the reinforcement arrives. In such cases the outcome of the training is called a *trace reflex.* It is more difficult to establish a trace response than a delayed response (56). In both types, however, the longer the interval between the onset of the two stimuli, the greater will be the number of trials necessary to secure conditioning.

The interval between the stimulus and the response is called the *latent period,* and the extent of the delay is known as the *latency* of the response. The latent period of both the delayed CR and the trace reflex is roughly equal to the training interval between the start of the CS and the appearance of the UCS. It increases during training and tends to reach a maximum slightly less than the time between the onset of the paired stimuli.

Inhibition in delayed response. The tendency of the subject to get drowsy and fall asleep during the experiments on the delayed and trace reflex in the case of dogs was observed and reported by Pavlov (45*d*). The delay, or latency, of the response after the onset of the CS, he believed, was due to the development of an internal inhibition. This inhibition tended, according to his interpretation, to spread from the point of direct stimulation to other parts of the brain. As it became general, the dog became drowsy and fell asleep. When this occurred, it was necessary to abandon the experiment, for it was not possible to produce conditioning in the dog when he was asleep.

Krasnogorski reports a similar tendency on the part of children to become sleepy in delayed conditioning experiments. A CR was established in a six-year-old child by presenting food five seconds after the metronome began. After conditioning was established, an attempt was made to delay the response by using an interval of thirty seconds between the start of the metronome and feeding. After a number of stimulations the response became very unstable and disappeared. The child yawned and became sleepy. Further training with the five seconds' interval re-established the response after several days, and further trials finally established it for the thirty seconds' interval of delay. Then a delay of sixty seconds was attempted. The child fell asleep during this experiment and later refused to go to the laboratory. After a week of rest the child went willingly to the laboratory and the conditioned reflex was established for an interval of 40.6 seconds between metronome and response.

These discoveries are significant for education. They suggest that the lethargy which appears in some children may be due to the fact that they are confronted with a task which at the time is too difficult for them; that this lethargy, loss of interest, boredom, is a matter of inhibition acting like a brake on their mental processes; that when it develops, it tightens down more and more, making progress impossible; that it is futile to try to fight against this condition by extra exertion, coaxing, or threats; that the only reasonable thing to do in such a situation is to lay the task aside for a while, give the child something else to do, and let him come back to this task later when he has recovered from this state. It was no accident that the child in Krasnogorski's experiment was able to achieve, after a week's rest, a task which before was producing an obstinate attitude and sleepiness.

Conflicts of stimulation and inhibition. It is significant also that these experiments indicate that learning tasks which involve a delay of the response are more difficult than those calling for an immediate response. The sustaining of such delays involves tensions and strains. The child is said to be impulsive. He acts "on the spur of the moment." The elaborate social adjustments required of him demand the inhibition of impulses and the timing of responses to fit the various social forms and codes. He must learn to wait until recess to tell his neighbor about the trip he has just taken. He must not interrupt his elders' conversation, no matter how urgently he wishes to call their attention to the fact that there is a dog-fight in the back yard. He must delay the satisfaction of biological urges until society gives the go-ahead signal. These conflicts of stimulation and inhibition are sources of emotional tensions, which often are more exhausting than parents and teachers realize.

Sleep. Pavlov interpreted his finding that the dogs tended to fall asleep during the periods of waiting in experiments on the trace and delayed conditioned reflexes in terms of his doctrine of excitation and inhibition of the neural processes, and described sleep as a condition of complete inhibition. It is believed that the natural stimulus for sleep is the accumulation of certain fatigue products in the system. These induce drowsiness and sleep. On the other hand, as fatigue is associated with lying down in a certain bed, lights out, and quiet, these conditions apparently serve as conditioned stimuli for producing the sleep response. The contact with the usual sleeping quarters, putting on sleeping garments, and assuming the sleeping posture may induce sleep as a matter of habit in the absence of fatigue. The response of going to sleep becomes so thoroughly conditioned to such accessory stimuli for some people that they cannot go to sleep in a strange bed or in a situation that is quieter than the one to which they have become habituated.

The time reflex. If food is given to a dog at regular intervals, the dog naturally salivates each time. Now if at the end of one of these intervals no food is given, the response tends to appear just the same. This has been found to hold for intervals up to thirty minutes. It is supposed that internal physiological processes here serve as conditioned stimuli. Such a response is called a *time reflex.*

Extinction of the Conditioned Response

The preceding sections have dealt with the conditions under which a CR is established. There are certain features of this form of learning that belong to the period following its accomplishment, which must now receive our attention. The first of these is known as *experimental extinction.* Pavlov (45*e*) pointed out that the natural reflexes were constant, mechanical, and unchanging, while the CR's were fickle and transitory. He described the latter as temporary reflexes. The artificial stimulus usually became effective for eliciting the reflex response only after it had been reinforced or followed by the natural stimulus several times. Except for certain cases of negative adaptation, the stimulus for the natural reflex may be presented alone as often as desired and it will continue to arouse the response. However, when the CS is repeatedly presented without reinforcement by the UCS, the response rapidly diminishes and soon fails to appear. Take the case in which the beating of a metronome has become a CS for producing the flow of saliva. If the metronome is run for the usual time, repeatedly, without being reinforced by food, the amount of the secretion will diminish from trial to trial until after six to ten times there will be no response.

It is to be noted that extinction is more a matter of a temporary suspension than of forgetting. That the CR is not completely abolished by this process, is shown by the fact that after a few hours of rest and without reinforcement the response tends to reappear, though perhaps not in its original strength. This reappearance of the CR without reinforcement by the UCS is called *spontaneous recovery.*

As a general rule it has been found that it requires fewer trials with reinforcement to re-establish conditioning after extinction than were required for the original learning. Although the number of trials required for such relearning is found to vary for different experimental conditions, usually reinstatement is accomplished in from twenty to forty per cent of the original number of trials required. Also, where the CR has been extinguished and revived by reinforcement several successive times, there is a progressive decrease in the number of reinforced trials required for relearning (19*e*).

After extinction a CR may sometimes be fully restored by presenting the UCS a few times alone, that is, without the CS. Thus, if the response to the metronome beats has been extinguished, it may be restored by giving the dog a little food a few minutes before the trial with the metronome. This is not regarded as true relearning but a matter of raising the animal's sensitivity to the CS.

It has been shown that if a CR is established and then extinguished, after recovery, it takes fewer non-reinforced stimulations to secure extinction a second time and that a third extinction is brought about by fewer trials than were required for the second (47).

That set or motive has an important influence on extinction has been shown by a number of experiments. Pavlov (45*f*) reports that the repeated presentation of food at a distance and not followed by feeding leads to the disappearance of the salivary response, but that the response disappears much more quickly in a satiated than in a hungry dog. Similar results have been found in studies on rats. Greater resistance to the extinction of a food-obtaining response was found with longer periods of food deprivation (57, 11). Razran (53) found the rate of extinction and forgetting to be much slower for the patterns of stimuli than for their individual components.

That the course of extinction is a reversal of the process of building up conditioning has been demonstrated by Hilden (18). After having conditioned the hand withdrawal to a light, he secured extinction by repeatedly presenting the light alone. He showed that in conditioning, slight muscular contractions too weak to produce overt movement (action currents) regularly appeared as CR's before the overt response was made to light without shock. These increased in magnitude during the process of conditioning. He found also that when the CR first began to appear, it was unstable and that there was an increase in stability as training was continued. This order of events was reversed in extinction. First, there was a decrease in the action current accompanying the overt muscular response. The overt responses became less stable and finally disappeared, but action currents were recorded after there were no overt responses. As the extinction trials were continued, these action currents gradually declined until finally all evidence of them disappeared. It seems apparent from these and similar findings that extinction is a gradual and progressive process and that it may continue beyond the point where overt response ceases.

A negative correlation has been found between the number of trials required for conditioning and the number of non-reinforced stimulations necessary for extinction. This means that individuals who require for learning the fewest trials usually are the ones who manifest the greatest resistance to extinction. In so far as such resistance may be taken as a measure of the degree of conditioning, it would seem that those who learn most quickly learn most thoroughly (19*f*).

Cases from everyday life analogous to experimental extinction of a learned response are plentiful. The story of the boy who cried "Wolf! Wolf!" too often, shows how a signal that ceases to be significant soon loses its potency for evoking a response. We tend to abandon responses having no adaptive value and to cease to attend to stimuli not significant to us. If this were not true and if we were permanently conditioned to all stimuli to which we respond, our response tendencies would be chaotic.

Extinction apparently results from two processes, *adaptation* and *interference*. In adaptation, inhibition of the response is brought about by continued repetition of the stimulus that normally produces it. This process, sometimes called *negative* adaptation, appears in the decrease and disappearance of many natural reflexes under repeated stimulation. It is seen, for example, in the lessening of the startle reflex as we become accustomed to certain loud noises, in the decrement of nystagmic eye movements and dizziness after repeated sessions of rotation, and in the gradual subsidence of the wink reflex as the felt hammer is repeatedly dropped against a pane of glass before one's eyes.

Inhibition by interference means that the response is checked or suppressed by a tendency to make some other response at the same time. Interference may be expected to contribute to extinction in so far as the experimental situation tends to arouse some response antagonistic to the CR. It has been noted that often during extinction other forms of activity increase as the CR weakens. It is believed that interference may come from several sources. Among these are changes in set and emotional states, the restoration of old response habits which existed prior to the conditioning, and tendencies to respond to other features of the total experimental situation than the CS (54, 19g).

GENERALIZATION AND DISCRIMINATION IN CONDITIONING

Generalization. One of the earliest discoveries in the studies of the conditioned reflex was that if a response is conditioned to a particular stimulus, the same or similar response will likely be made to another somewhat similar stimulus without specific reinforcement. A dog trained to salivate in response to the metronome sounding at the rate of 120 beats per minute will also salivate when he hears the metronome beating sixty times per minute. If he is conditioned to respond to one musical note, he will tend to respond in a like manner to other notes. A subject conditioned to lift the finger from the electrode at the sound of a buzzer responds in this manner to the sound of a muffled bell.

This tendency to respond to stimuli similar to the CS is known as *generalization*. It has been shown that the degree of generalization diminishes as the difference between the other stimuli and the reinforced stimulus increases. The greater the similarity, the stronger will be the tendency to react to stimuli not used in training (20).

The ability to extend the results of one's training and experience to other situations is a matter of fundamental importance in the development of adaptive behavior since total situations probably never repeat themselves in identical form. However, it is necessary in the interest of appropriateness of response that one learn to react with discrimination.

As learning takes place, there is a tendency for generalization first to increase or to become more widespread up to a certain point, and then with further training it tends to decrease. This means that in the early stages the response is made to more and more diverse stimuli, and that as learning continues, it becomes progressively restricted.

This principle may be observed in the case of children. In the early stages their acquired responses are frequently made in an indiscriminate manner to a wide range of stimuli, but as their experience increases they learn to react more and more selectively. A year-old child had learned to say "dog," and when taken to see his two-weeks-old cousin, he looked at him and exclaimed, "Dog." A youngster two years old went on an outing with his family. He was sitting on the ground near his father when he suddenly exclaimed, as he pointed to a small black bug on his father's hand, "Daddy, look! A bear!" Another small boy at about eighteen months always said "bogey man" whenever he saw anything black, even a darkly shaded picture of a landscape. A little girl taking the Stanford-Binet vocabulary test was asked, "What is *health?* What does *health* mean?" Her reply was, "It means to help Mamma." Many of the difficulties of young children learning to read are due to the fact that similar letter patterns are not discriminated. They respond incorrectly to a word because in print it looks like some other one they know, as when "ant" is called "and" or "roar" is confused with "oar." The novice at tennis strikes at balls that are soaring out of bounds. In novel situations an individual tends to react as he has been accustomed to react to similar situations. Marks of similarity in the situations tend to evoke similar behavior.

Generalized conditioned responses have been found, however, to extinguish more rapidly in experiments on extinction than the response to the stimulus reinforced during the training period (21). It seems, therefore, that they are not so thoroughly learned and that the direct training is the most effective.

Discrimination. Generalization is reduced and the range of stimuli that elicit the CR narrowed, if training is continued with reinforcement for the CS and without reinforcement for the other stimuli. If the sound of the metronome, for example, has been conditioned to evoke salivation and this stimulus is frequently accompanied by feeding, other sounds tend to lose their effect if they are never followed by feeding. Then if the experiment is continued with different metronome rates and with reinforcement only when the metronome beats at 100 per minute, the dog will learn to discriminate the different stimulus-rates. In this manner he can be trained to the point where beats at the rate of 100 per minute will cause saliva to flow, but faster and slower rates will have no effect. If the response has been conditioned to skin irritation at one point, continued training, which frequently reinforces stimulation at this point but not at other points, will develop differentiation so that the response will occur only when this particular spot is scratched. In this way, also, the dog is trained to salivate in response to one particular tone and not to others, and a monkey learns to run to the food box when a red card is flashed and to ignore a blue card.

Limits of discrimination. A number of experiments on discrimination have been concerned with discovering its limits. The question here is just how closely can a similar stimulus resemble the reinforced CS and still be distinguished so that the CR will not be made to it.

One of the Russian experimenters secured discrimination in dogs between tones of 800, 812, and 825 vibrations per second. In other experiments dogs were trained to discriminate ninety-six metronome beats per minute from 100 per minute, and the scratching of one point on the skin from the scratching of other near-by points.

In the case of the trace reflex, discrimination of similar stimuli appears to be more difficult than in simultaneous conditioning. The fineness of discrimination is reduced as the interval between the CS and the UCS is increased.

A student of Pavlov trained a dog to salivate at the sight of a luminous circle projected on a screen. After this conditioning was well established a small ellipse was presented. The ratio of the axes of this ellipse was one to two. No food was presented with it. The dog soon learned to distinguish the two forms so that no response was made when the ellipse was shown. Then the ellipse was gradually made more circular. The dog successfully discriminated even when the axes of the ellipse were as seven to eight. But at the eight-to-nine ratio the difference between the circle and the ellipse was too small. Discrimination completely broke down. The saliva flowed indiscriminately at the sight of either the ellipse or the circle. It appeared at the sight of the apparatus, the experimenter, or in response to any stimulus. The dog appeared greatly excited. He barked violently, yelped, tore at his harness with his teeth, and broke up part of the apparatus. After that the animal could no longer be used for experimental purposes (44*c*).

An experimental nervous breakdown. Such a breakdown of the normal control of behavior has been observed in many other cases and with other animals. Outstanding among the studies that have dealt with this problem are those of Liddell (32, 33), who experimented with sheep, and Maier (36), who found similar results with rats. Because of its marked resemblance to the neuroses of human beings, it has been called "experimental neurosis" or a "nervous breakdown." The neurotic person, like these animals, suffers from conflicts between impulses and inhibitions, uncertainties, and emotional stresses in which behavior is disorganized and responses are not discriminated. He fears indiscriminately a large number of harmless things, suffers from his phobias for cats or sticking doors, or trembles violently at the sight of a streetcar, high places, or large bodies of water. He is borne down and exhausted by anxieties, useless activity, and manifests behavior inappropriate to the circumstances. Such are the symptoms manifest by the victim of a neurosis who finds the task of adjustment to life's demands beyond his ability.

Restraint and forced decisions. The studies on experimental neurosis have shown that nervous strain, which may lead to the neurosis, is caused by too much restriction of freedom of movement, which serves to block normal motor outlets, and by being forced to make difficult decisions that cannot be avoided or postponed (34). These findings are of utmost significance for the parent and classroom teacher. The fact that excessive restraint of the child's physical activity is a source of emotional tension and nervousness should be more widely recognized than it is at present. Putting into practice the pernicious notion that "a child should be seen and not heard" may be more agreeable to the parents than the normal and wholesome activity of a healthy child, but the best interests of the child require that he be allowed a reasonable outlet for his motor impulses. School tasks requiring decisions beyond the child's capacity, pressure brought to bear to force a child to choose between alternative responses for which by maturation or training he is not prepared, especially where serious consequences for him result from the wrong choice, can produce great harm to his emotional life. The good teacher will see many school situations where this may happen and will strive to avoid perpetrating such unsound practices on the child. The choice of a right and wrong method of spelling a word, the selection of the appropriate procedure for solving a problem, choosing a suitable item to report for current events, picking the proper form of punctuation, or, in reading, selecting the appropriate meaning of a word from its context, are just a few of the many classroom decisions a child is called upon to make. Before he is forced to make these, a child must be adequately trained for them or else the teacher must refrain from making a child miserable if he happens to "jump" the wrong way.

Evidence from experiments on children. It is of course necessary to use caution in interpreting the results of animal experiments for human learning, and for obvious reasons it is not expedient to produce experimental or any other kind of neuroses in children as a matter of research. Still there is evidence from the laboratory to show that such situations as those described above do upset a child emotionally and disorganize his behavior. An experiment by Krasnogorski (31, 61) bears directly on this point. A child six years old was conditioned to respond to a metronome beating at the rate of 144 times per minute. The child was fed when the instrument was beating at this rate, but he was not fed when the rate was ninety-two beats per minute. He soon learned to discriminate to the point of no response for the latter rate. Then the training was continued with 108 beats as the negative stimulus. Differentiation was accomplished at this level; and then the experimenter proceeded to secure differentiation between 144 and 120 beats. The child became irritable and objected to going to the laboratory. When differentiation between 144 and 132 beats was attempted, the child became very nervous and excitable; he cried, fought with other children, lost his inhibition for the response to 120 beats, yawned and became sleepy.

The description of the behavior of this child reads remarkably like the case studies of behavior problems encountered in the schoolroom or on the playground. The source of the latter presumably is much the same as in this experimental case. The emotional stress generated by a task too difficult breaks up the inhibitions that may have been developed previously and produces apathy and an indifference to the work of the school. This apathy and indifference may fortunately serve to protect the child against a devastating sense of humiliation and the misery of frustration. If he does not care to succeed, he will be spared the pain of failure.

The Influence of Distracting Stimuli

If a CR has been established, an additional stimulus presented along with the CS will often prevent the appearance of the response. Pavlov (45*g*) pointed out that after the scratching of a point on the skin of a dog has been conditioned to produce salivation, the scratching loses its efficacy as a stimulus for this reaction if a beating metronome is presented at the same time. Likewise, a tone sounded at the time of the scratching rendered scratching ineffective as a CS (45*h*). A subject conditioned to withdraw her finger from an electrode at the sound of a bell failed to respond when her other hand was touched by a ruler at the same time the bell rang. This temporary reduction or abolition of a CR by a distracting additional stimulus Pavlov called “external inhibition.” Such an inhibition usually lasts only as long as the interfering response to the distraction continues. A short time after the distracting stimulus is removed, the CR may again be produced at its former strength. The extent of the inhibition depends somewhat on the nature and intensity of the interfering stimulus; and old and well-established CR’s are usually disturbed less by distractions than are responses which have been newly conditioned.

New habits broken up. The inhibition of recently learned responses by distractions is not limited to laboratory experiments on conditioning. Examples abound in all phases of human behavior. The motorist loses control of his car when stung by a bee. The golfer’s shot is spoiled if a companion speaks to him just as he swings at the ball. We hand the baby an interesting toy to stop his crying. The lecturer loses his trend of thought when disturbed by whispering students. The orderly quiet of the classroom vanishes when a puppy enters the room. It is not mere cussedness that causes children to forget their table manners when there are guests for dinner. The behavior of children is generally more subject to interference by distractions than is the behavior of adults. This is probably due to the fact that their habits are newer and therefore less stable.

Disinhibition by distraction. Pavlov (45*i*) describes an experiment in which salivation was established to a light to the point where the light produced the secretion of ten drops of saliva. Then a tone was presented with the light. This combination resulted in no response. The tone inhibited the response to the conditioned light stimulus. When a light was presented with a tone and also the metronome, there was a secretion of four drops of saliva. The metronome as an extra agent tended to counteract, though not fully, the inhibiting effect of the tonal stimulus and released the previously repressed action. This Pavlov regarded as the inhibition of an inhibition. It has come to be known as *disinhibition.* As contradictory as it seems, we frequently run across this phenomenon in everyday life. One hears, for example, of amnesia being caused by one shock and later removed by another.

The restoration of an extinguished conditioned response. If a CR is extinguished, the response may be elicited by adding some other agent to the CS that has lost its effect through extinction. Thus, if light has, through appropriate training, become a CS for producing the flow of saliva, and then extinction is brought about by repeating the light without feeding, some additional stimulus presented with the light may restore the response to the light. It will be remembered that extinction is considered a state of suspension of the response due to an internal inhibiting process. So here again the effect of the distracting stimulus is disinhibition, or the breaking up of the inhibition.

This inhibiting and disinhibiting effect of a distracting stimulus in human subjects has been carefully studied by Razran (55). After conditioning the salivary reaction to a flash of red light, he applied a buzzer at twelve different stages of extinction of the conditioning. He found that there were two apparently opposite effects produced by the buzzer. It suppressed the tendency to react to the light and at the same time it counteracted the effects of extinction. The greater the degree of extinction, the greater was the restorative effect of the buzz. He found the incremental effect of the buzz to be greater than its inhibiting influence.

The reader will recall, no doubt, cases of some old habit he has tried to suppress, reviving when he was distracted. Perhaps it was an old speech fault, or the use of profanity. The distraction somehow seemed to throw him off guard, or to let down the barrier, and then the old grammatical error or the old "cuss word" slipped out.

The disruption of discrimination. Disinhibition by distraction may cause a loss of the ability to discriminate between the reinforced stimulus used in training and other stimuli which resemble it. If, after the dog has been trained to differentiate between tones of 800 and 812 d.v. or between metronome beats of ninety-five and 100 per minute, a distracting stimulus is presented with the negative stimulus, differentiation is destroyed. The habit of not responding to the negative stimulus is inhibited and the similar stimulus again calls forth the response as it did before discrimination was developed. Such a disinhibition may last ten or fifteen minutes (45*j*).

The everyday counterparts of this kind of disinhibition are seen in the loss of discriminative reactions in many situations. The baseball player, who at bat has learned to let the high balls go by, in moments of distraction swings at them. The interrupted typist strikes the wrong key, and the disturbed speaker makes an awkward selection of words.

The effect of distraction on the delayed CR. As Pavlov explained it, the delay of the delayed CR is brought about by the development of an inhibition that holds back the response until the proper moment for its appearance. The experiments with the distracting stimuli have shown that if during this interval of delay some other stimulus, strong enough to attract attention, is presented, the delay is abandoned and the response no longer waits. The distraction removes the restraining check and releases the response at once. When this happens in delicately timed reactions of certain skills, the consequences may be disastrous to the performance. The football player plunges across the line of scrimmage before the ball is passed, and the motorist starts his car forward too soon after waiting at an intersection. In general, it may be concluded that distraction is inimical to self-restraint.

Conditioning in Infants

In the early days of experimental conditioning, when it was believed that conditioning required an intact cerebral cortex, it was assumed by the Russian investigators that it was impossible to develop a real CR in young infants because of the undeveloped condition of the brain. Krasnogorski succeeded in conditioning the salivary reaction in the second half of the first year, but he held that before that time the response could not be secured from an artificial stimulus since the cerebral cortex functions very imperfectly at that age. Mateer's results were in general accord with the findings of Krasnogorski. She did not study children under one year of age, but for children under five years she found the younger the child, the greater was the number of trials required to establish the CR (39*b*). However, since that time there have been a number of studies aimed at finding out how early in life this kind of learning can be achieved.

D. P. Marquis (38) secured conditioned behavior in seven out of eight infants during the first ten days of their life. Immediately preceding each feeding from a bottle a buzzer was sounded for five seconds. After three to six days signs of conditioning began to appear. As the buzzer sounded there was a decrease in general bodily activity and an increase of sucking and mouth-opening movements. In a control group, which was not fed following the buzzer, no such change in behavior appeared. From her results, this experimenter concluded that it is possible to establish conditioning during the first ten days of life and that in view of the fact that the cortex at this time functions very imperfectly, it is possible that such conditioning takes place at the subcortical level. This latter conclusion is in keeping with the findings with respect to conditioning in decerebrate animals.

Wenger (68) reports conditioning of the eyelid closure to tactual vibration applied to the foot in three infants as early as the fifth day of life. However, eight weeks of training failed to secure conditioning of sucking movements to auditory stimulation. Sucking behavior was reported conditioned to a buzzer by Kantrow (29) in sixteen infants ranging in age from six to fourteen weeks. Other investigators have reported sucking movements conditioned to the sound of a bell and to an organ note in the second month, to a red light at two and a half months, and to a metronome at the beginning of the third month (9). A maturational factor is indicated by the fact that differentiation of tones has been found more effective at four months than at three months (30, 48).

These experiments on infants are important to the student of learning because of several things they reveal regarding the modification of behavior during the first few weeks of life. In the first place, they show that at best conditioning is established with difficulty during the first few days following birth, and that if established during this very early period, it is very unstable. They have shown that younger infants require more trials for conditioning than older ones. There is, therefore, definite evidence of a maturational factor which limits and regulates modification.

These studies indicate, also, that practically from birth the child learns. Environmental stimulation operates to alter the behavior of the neonate. This suggests that no sharp line can be drawn between so-called "instinctive" and acquired behavior, and that the training of infants in socially acceptable and hygienic habits can be properly undertaken very soon after the child is born.

The evidence is clear, also, that there are individual differences in learning ability even in the first few weeks of life. Some infants require more trials for conditioning than others of the same age. Moreover, the number of trials required for successful conditioning varies for different stimuli and for different types of response.

Finally, these studies indicate that infants are not promiscuously conditioned to any and all stimuli that reach them. Even the very young infant exhibits an ability to utilize significant external signals and to disregard those having no value for him. He is not wholly fabricated by the stimulus-patterns which the environment presents. He bears within himself checks and trends, which restrict the area of conditioning and maintain an orderly balance in the development of the complex patterns of adaptive behavior.

Treatment of enuresis. A useful application of the principle of conditioning has been made in the treatment of enuresis by Morgan and Witmer (43). A pad placed under the child was connected with electrical apparatus so that wetting the pad closed the electric circuit and rang a bell, which awakened the child. The child was instructed to go to the toilet at once upon awakening. Here bladder tension, which always preceded bed-wetting, was the CS, and the bell was UCS for the response of waking. After a few trials the child was awakened by the bladder tension. Of five cases of chronic enuresis, four learned to get up and go to the toilet in place of wetting the bed. The fifth had bladder trouble, which required medical treatment.

Conditioning in Relation to Learning

The extensive research done on conditioning during the past two decades has extended our knowledge of this subject in many directions. With this increase in knowledge have come new conceptions but not agreement about the relation of conditioning to learning in general. The view adopted by the radical behaviorists of Watson's time, that all acquired forms of behavior are merely compounds of conditioned responses, has passed with the decline of that narrowly formulated approach to the study of psychology. In general, it can be said that with better understanding of conditioning has come a more tempered attitude and greater moderation in claims for its theoretical importance.

Some psychologists believe that the principles discovered in experiments on conditioning are operative in higher forms of learning and that they may be found adequate to explain the development of all forms of adaptive behavior (15, 22, 23). Others are inclined to the view that all learning cannot be accounted for in terms of conditioning principles alone. Some writers regard conditioning as a distinct form of learning. Others believe it represents only the "animal" form of human learning, which operates best when the conscious and attitudinal controls are underdeveloped or suppressed (49). Some have noted similarities between conditioning as observed in experiments and the more complex forms of human learning, and while admitting that some conditioning principles may serve as explanatory concepts, hold that additional concepts are needed (42).

It seems clear that the learning which occurs in experiments on conditioning does have much in common with that which takes place in the schoolroom and in the various situations of everyday life. But there are so many other factors entering into the higher forms of learning that the task of developing an all-embracing theory from conditioning principles becomes exceedingly involved. It means that these principles must be extended to explain not only the development of complex skills, memorizing, comprehension, and problem solving, but that they must account also for such factors in learning as attitudes, volition, motives, goals, conscious processes, insight, and meanings. The fact that this appears difficult and involved does not mean that it cannot be accomplished. Noteworthy progress has already been made in this direction (24, 25).

Conditioning experiments represent comparatively simple forms of learning carried out under the artificial, made-to-order conditions of the laboratory. The processes must necessarily differ in many ways from those of acquiring such skills as writing or reading in the classroom, or of learning to run a steam shovel. Many analogies to the higher forms of learning may be found in the data obtained from conditioning experiments, but the former include a much wider range of factors than are usually involved in the controlled laboratory experiment. At present it seems that we cannot obtain from this source alone all we need to know for directing the learning of pupils in the classroom.

The evidence is clear that the CR is an acquired or learned mode of functioning. Through the process of conditioning, the reaction tendencies are modified so that changes in behavior appear. The facts of conditioning do, therefore, present us with at least a fundamental principle of learning. They show us the conditions under which much of animal and human learning takes place.

Functional modification in conditioning. Under the conditions which govern activity in a conditioning experiment a series of changes in reaction tendencies are brought about. These in turn produce a new form of functioning. Two things should be borne in mind in considering the nature of this change in activity: 1. the learner's performances are governed by the whole situation, a pattern of stimuli and motives, not by a single, isolated stimulus, and 2. the total functional unit is changed both with respect to the agents which set it off and with respect to the manner of reacting to the situation.

For convenience of discussion we have spoken of the response to the unconditioned or the conditioned stimulus. This is possible only because of the care exercised by experimenters to control and keep constant other features of the total situation. In doing so we are referring to the particular agent of the total situation which before or after conditioning is essential along with other factors for the initiation of the function. The experiments themselves have supported the whole-situation concept. We have observed that the CR is affected by additional or distracting stimuli, that the animal must be "accustomed" to the experimental situation, and that it is necessary in many cases to extinguish responses made to elements of the situation other than the particular one the experimenter has selected as the one to be conditioned. The influence of attitudes, purposes, and organic conditions has been amply demonstrated. So while descriptions of experiments on conditioning commonly speak of the response to this or to that stimulus, the learner's activity is the outcome actually not of this stimulus alone but of the total situation just as truly as in any other case of learning.

In conditioning, first there is some factor of the total situation that is essential for securing the response, just as pressing the starter button is necessary to start the engine of your car. At the beginning the situation is inadequate to initiate the function because it lacks this essential agent. To this ineffective situation is added (inclusion) the factor that will set off the desired activity. This is the "unconditioned stimulus." The new total situation now elicits the function in question. After a number of responses to this new situation comes the reduction of the stimulus-pattern. In an earlier section on forms of functional modification it was pointed out that a situation may under certain circumstances elicit a response even when it lacks elements that at an earlier time were essential for that response. That is what takes place in the second phase of conditioning. In this case the experimenter eliminates or omits the UCS, originally essential, and secures the response to the remaining situation, which was at first ineffective. Sometimes it is a case of the learner not waiting for the UCS.

In speaking of the situation above as ineffective, it is meant that it is ineffective only with respect to the particular response in question. It may be effective for producing some other form of response, as, for example, when the dog, before conditioning of the salivary response, pricks up his ears and turns his head at the sound of the bell. In such cases, the response made to the situation after the UCS is added will depend upon the potency of the UCS as a factor in the new situation. The response will be like that made originally to the UCS if the effect of the latter outweighs the influence of the other factors of the new situation. This means that as conditioning is achieved, a change is made in the mode of reacting to the original situation, and it means also that for the response in question a new pattern of stimuli has become effective for its arousal.

This double aspect of functional modification, which takes place in conditioning, may be illustrated by the case of a dog that playfully runs to a boy. Sight of the boy causes the dog to run to him. The boy strikes the dog with a stick. The dog runs from the boy to escape the beating. Later, sight of the boy causes the dog to run away. Thus, sight of the boy, instead of beating, causes the dog to flee, and running from has replaced running toward the boy. The dog's behavior has been modified both with respect to his running when he sees the boy and with respect to the cause of his flight.

It should be noted, however, that the reaction to the sight of the boy in the case cited may not be an exact duplicate of the behavior elicited by the beating. The dog may yelp at being struck and make violent lunges in his effort to get away, while his retreat upon seeing the boy may be a furtive slinking away with tail between his legs. Thus, the CR is not exactly the same as the UCR, and conditioning is not the simple process, as sometimes maintained, of merely attaching a given response to a new stimulus.

There is evidence at hand from many experiments to indicate that the CR, as well as the stimulus, varies from the original. The CR may differ from the UCR in both magnitude and character. The conditioned knee jerk, for example, has a longer latency and a slower pickup than the reflex. In these respects it resembles the voluntary kick (58). The trained dog's precise lifting of the leg at the sound of the buzzer to avoid shock differs from the generalized struggling produced by the shock itself, though in the early stages of conditioning the buzzer sets off similar behavior (7). In Pavlov's experiments the dog not only salivated when the CS was presented, but turned toward the source of the food, or, if not restrained, walked toward it. Sometimes he made restless movements, such as stepping about or panting. This was not identical, of course, with the eating behavior that followed the presentation of food. It was in the nature of preparatory activity made in anticipation of being fed. Pavlov considered the salivary response to the bell to be the same as that made to food, and this response was all he cared about. He disregarded the motor accompaniments.

Rats trained to jump over a low fence to escape shock at the sound of a buzzer responded to the buzzer with a smooth and accurate jump, while the jumps made in response to the shock were jerky and uncertain (64). A number of experiments have shown that while the end result of the conditioned activity may be the same as that of the unconditioned behavior, the neuromuscular mechanisms involved are not necessarily the same. Thus, in conditioning, the response as well as the stimulus-pattern is modified. The CR differs from the UCR and frequently it is anticipatory to the appearance of the UCS.

These observations have provoked much explanatory discussion. Guthrie explains the variations in the response as due to additional stimuli in the total situation including proprioceptive cues. As these change, behavior is altered (13, 14). According to Tolman, the animal learns to expect or anticipate from "signs" certain consequences, such as punishment, and may act in various ways to avoid it according to his innate or acquired tendencies (63).

Thus, we find that in conditioning as in other forms of learning the learner's reactions are made in response to the total situation, are initiated and controlled by motives and attitudes, and bring about a series of functional modifications in the direction of smoother and more appropriate performance serving to bring the learner to his goal, or to satisfy the demands of his motives. The changes in the functional pattern involve more than simply attaching a given response to a new stimulus. Those concepts of Gestalt psychology which are coming to be generally accepted in modern psychology are quite out of harmony with the notion of inflexible stimulus-response units of behavior. However, when all the facts which experiments on conditioning have revealed are taken into account and interpreted in terms of functional modification, they do not stand opposed at all to the holistic point of view in which goals, insight, total situations, and the molding of whole functional patterns are stressed (69).

SUMMARY OF THE CHAPTER

Conditioning is a process of learning in which a new way of reacting to a situation is developed. It takes place when there is added temporarily to the situation a stimulus (UCS) that is sufficient to produce a different reaction.

Experiments on conditioning involve isolation of the CS and repeated paired stimulation by the conditioned and unconditioned stimuli. In configural conditioning a response is conditioned to a pattern of stimuli. The best temporal arrangement of the CS and the UCS is to have the former precede the latter by less than five seconds. When during the training there is an interval of delay between the onset of the CS and the appearance of the UCS, after training there is a corresponding interval of delay between the CS and the CR. The CR is then called a *delayed* or *trace reflex*. The establishment of a CR is influenced by sets, attitudes, and motives. There are pronounced individual differences in the ease with which conditioning can be established even among subjects of the same age and species. Conditioning to a limited extent can take place in the lower brain centers, but the cortex is essential for the more refined developments of adaptive behavior.

Without reinforcement by means of the UCS the conditioned reflex soon disappears under repeated presentations of the CS. This is known as *extinction*. When a CR has been established, the subject tends to make the same type of response to stimuli which resemble the CS. This is known as *generalization*. Discrimination between the CS and similar stimuli may be developed by further training in which only the former is reinforced. If the demands for discrimination are carried too far, the subject suffers a breakdown of inhibitions, a condition referred to as "experimental neurosis."

Distracting stimuli tend to inhibit a CR, impair discrimination, and disrupt the delay of a delayed CR. Studies of infants indicate that it is possible to condition certain responses during the first few days of life, but that such early conditioning is difficult and unstable.

In conditioning, functional alterations are made with respect to the stimulus-pattern that sets off a reaction. The CR is not an exact duplicate of the UCR. The data from conditioning experiments have thrown light on the fundamental nature of learning. They are in keeping with the view that the learner's behavior is determined by the total situation and that learning involves changes in the total psychological function. They indicate that conditioning is not simply a matter of substituting one stimulus for another.

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CHAPTER VIII

RELATIONSHIP AND ORGANIZATION

The principle of relationship and organization. *Learning is a process of organizing experience by discovering and developing meaningful relations.*

The "principles" represent various aspects of learning. In the previous chapter our attention was devoted to the extensive and careful experimental work that has been done in one area of the subject of learning. The experiments have been fruitful in throwing into relief some of the circumstances in which a change in functional trend is brought about. They have revealed a fundamental aspect of the learning process. Other experiments carried on with different types of procedure and with different problems in mind have focused attention on other aspects of learning. The experiments of the puzzle-box type or maze running with cats and rats have been especially suited to showing the circumstances under which learning appears as a process of trial and error.

The principles of varied activity and of conditioning are not in opposition; nor do they impose on us two incompatible theories of learning. They supplement each other in giving a more nearly complete picture of learning in general than either one of them alone can do. It seems likely that both operate more or less in all cases of learning. There is conditioning in trial-and-error learning, and it appears that a certain amount of trial and error takes place in conditioning experiments. Take, for example, the case of the conditioning of the flexion of a foreleg in a dog. When the shock as the UCS is applied, there appears general activity, a struggling type of behavior in which the dog lurches from side to side, barks, growls, and lifts all four feet from the floor. At first this is transferred to the buzz, the CS. As training is continued, the unnecessary reactions are eliminated, general struggling ceases, the non-shocked feet stay on the floor, and eventually a neat, localized flexion of the stimulated foreleg is made in response to the buzz (7). The character of the experimental procedure, the nature of the subject, and the type of problem serve to bring into the foreground one or the other of these two principles. In some learning situations trial-and-error procedure is the predominant feature, while in others, where the range of response is restricted, the principle of conditioning stands out.

Likewise, set, repetition, and the degree of maturation operate along with the varied activity and conditioning in any given case of learning. There is always some form of motive in any learning. Repetition of trials is involved in learning that is mainly trial and error in character, and we have seen it employed in all of the experiments on conditioning. The principle of maturational limitation was demonstrated in the conditioning experiments on infants. In short, the principles of learning we are considering are not isolated from one another; they do not represent distinct kinds of learning; no one of them is presented as a comprehensive theory to explain all learning. They are broad generalizations setting forth the conditions under which learning takes place. A comprehensive view of the learning process requires them all.

Relations and organization in learning. We now come to the consideration of another important feature of learning. It is to be seen as something universally characteristic of learning. It is not foreign to or in conflict with the facts and principles already discussed, but rather has its place along with them in the total picture of learning. This fundamental feature of learning, noted by all careful students of the subject though discussed under different names by writers of different systematic bias, is the *utilization of relations and organization.* It is perhaps not as conspicuous nor as dramatic in the simplified, highly controlled, and artificial setup of experimental conditioning as in the higher and more complex cases of learning that take place in more natural situations. The degree to which it stands out varies with the type of experimental procedure, the intelligence of the learner, and the amount of previous experience that may be brought to bear on the problem.

As learning takes place, new relations are established; new patterns of experience are organized, from which emerge new meanings, new insights, and new understanding. This may bring the sudden apprehension of an object in perception, the grasping of a topic, the solution of a thought problem, or a rather abrupt abandonment of haphazard and ineffective behavior in favor of an orderly and direct approach to the goal.

There are many types of relations involved in learning. They have been discussed by various writers under such names as configuration, organization, association, belonging, signs, meaning, and insight. It is not implied here that these terms are synonymous. They reflect different points of view and to some extent different aspects of the general matter of relationships. However, they have so much in common that it has seemed feasible to consider them all as falling under one general principle which we have made our sixth fundamental principle of learning.

Definition of relations. By *relation* in this discussion is meant any sort of connection between two or more things, which is perceived, remembered, or imagined. There are many different kinds of relations. Some of the more familiar ones are: *causal,* which obtain when one event is seen as the cause of another; *spatial,* found in factors of direction, proximity, or distance, when they are apprehended as pertaining to two or more things; *part-whole,* when one thing is observed to be a part of another; and *temporal,* when events are compared with respect to the element of time. Relations are seen in the connection of an individual with his group, in the reference of a word to the object it symbolizes, and in that which appertains to an act by virtue of its being regarded as a means to an end. Organization is founded on relations. It is to be found in patterns of sensory qualities in perception and in the orderly sequences of movements which characterize skilled performances. Organization implies the existence of relations between parts arranged to form a systematic and unified whole.

RELATIONS AND ORGANIZATION OF THE SENSORY FIELD IN PERCEPTION

All learning is based directly or indirectly upon observations made by means of the sensory mechanisms. The perception of objects or events is essentially a process of organizing and finding significance in the sensory experiences aroused by the external situation. A disorganized sensory field is a meager and inadequate source of meanings. It is likely to have little or no significance for the organism.

Figure and ground. The sensory field in perception is organized first with respect to figure and ground. The thing perceived stands out against a background, as when a ship at sea is seen against a background of indefinite expanse of water and sky, a farmhouse against the fields and hills of the landscape, and a star against the darkened dome of the heavens.

The character of the figure-ground aspect of perception is readily seen in certain simple designs, such as the one shown in figure 1. Here one perceives the figure of a cross outlined against the surface of the large square as the ground. Possibly one may make the large square the figure. Then the area enclosed in the cross becomes a part of the general expanse of the ground. We have then merely a cross-shaped opening in the central part of the square.

In figure 2 the black area is figure, and the white area is ground when one sees a black face looking toward the right. When one sees a white face looking to the left, the white area is figure and the black portion is ground. It is to be noted that the change in figure-ground relations appears without a change in the designs themselves, but with this change comes a different meaning. Something different is seen. Thus, the figure-ground aspect of perception is an arrangement of the sensory field, or the way in which the individual organizes the situation for himself. It is a fundamental determiner of what one sees and of what one learns by way of observation.

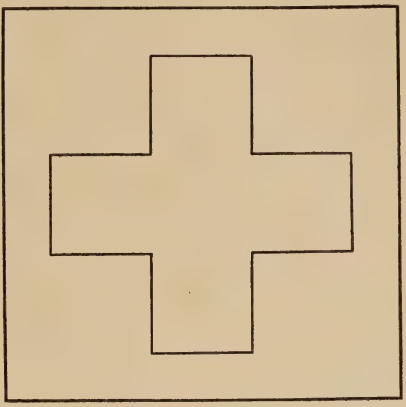

Fig. 1. Figure-ground pattern. The cross may readily be perceived as a figure, whereas the surface of the square serves as the ground.

Certain characteristic differences between the figure and ground are to be noted. In the first place the figure has more or less definite form. It is compact with fairly distinct boundary lines that mark it off from the ground. The figure may be complex, but its parts in clear perception are always closely patterned to form a unified whole. The ground on the other hand is formless and indefinite. The figure seems to stand forth, usually in front of the ground or surrounded by it. Elements of the sensory field not incorporated into the figure lack significance and seem not to belong to anything in particular. Note that when the black portion of figure 2 is perceived as the face looking to the right, the black dot in the white area is not related to the other parts at all, and it has no particular meaning. But when the white part is figure and a white profile is seen, the black dot occupies an essential position in the figure and definitely is

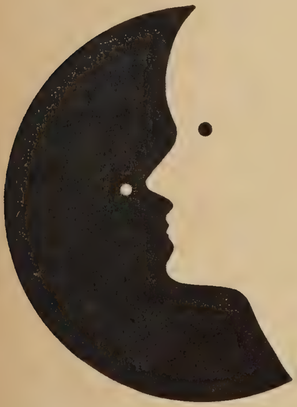

Fig. 2. Reversible figure-ground relations. Either of two faces may be perceived according to which area, the black or the white, becomes the figure.

an eye. The part is what it is by virtue of its relation to and membership in the whole figure. The common experience of failing to see some object before one's eyes, even when attending to it, is probably often due to failure to incorporate it into a definite figure pattern.

In the case of a puzzle picture, a person may look at a mass of lines and shadings and perceive a landscape with trees and rocks. Then he reads the instructions, "Find the hunter." As he scrutinizes the picture, lines and shadows suddenly snap together forming a new configuration for him and a new object-meaning appears. What at first were branches and leaves of a tree, now have become clearly and certainly the picture of a man with a gun. No change took place in the ink pattern on the paper, but a change occurred in the observer's patterning of his own experience, and with it a new object of perception appeared.

The stimulus-pattern and perceptual organization. While the patterning of the visual field is established by the observer himself and is to be seen as a matter quite distinct from the stimulus-pattern presented to his receptors, it frequently happens that the character of the stimulus-pattern influences or even dictates the way the sensory qualities are organized. The way the dots are printed in figure 3 makes it almost necessary to see a group of four at the upper left, a group of six at the upper right, and a line of seven below. Parts of the stimulus-pattern lying close together and set off from other parts are, as a rule, readily experienced as a unit or figure.

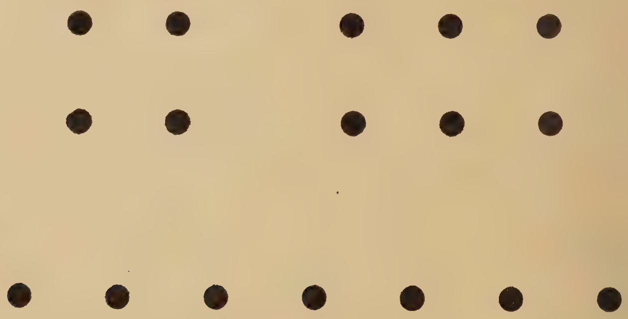

Fig. 3. Influence of the stimulus-pattern on the organization of the perceptual field. Dots lying near together are readily grouped into units.

Figure-ground relations, moreover, are not restricted to visual perception. They appear in perceptions of sound, taste, smell, and touch, though in these the boundaries may be less sharply defined. The grouping of the sound elements into tonal patterns in music is controlled largely by the stimulus-pattern sent forth by the instruments. Rhythmical units may be established by regular variations of intensity, pitch, or length of interval. Thus, if we are listening to a series of clicks and every third click is louder, or different in quality, or is followed by a longer interval, the stimulus-pattern gives the advantage to grouping in units of three. Here we have grouping in temporal sequence, whereas in the examples given of visual perception the grouping is spatial, or a side-by-side arrangement.

However, even where the stimulus-pattern does not favor any particular form of grouping, there is a tendency on the part of the observer to set up groups and patterns. In figure 4 we have a group of thirty-six small circles arranged in regular order in uniform rows of six. But in addition to seeing rows of six, one can also see quite readily groups of four, six, or nine arranged in blocks within the larger pattern. These minor groupings may change without the aid of changes in the printed pattern. If we listen to a perfectly uniform series of clicks, we are prone to find groups of two's, three's, or four's, by "subjective accentuation." It becomes "click-click," "click-click," or "click-click-click," "click-click-click," and so on.

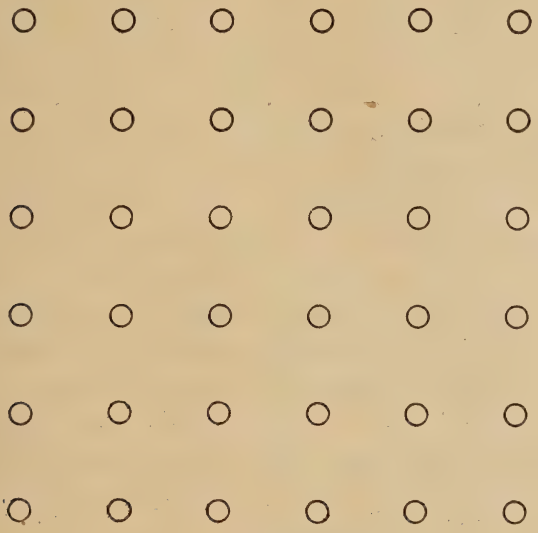

Fig. 4. Organization of the perceptual field. Minor groupings of 4, 6, or 9 may be established and changed without change in the printed pattern of circles.

The influence of familiarity. In some cases the sensory field is organized more readily than in others. Familiarity with an object of perception facilitates the establishment of an appropriate figure-ground pattern. When we look at familiar objects or hear familiar sounds, the pattern takes form readily and a clear apprehension occurs at once. This is because the perceptual trends have been established by our seeing similar things and hearing like sounds many times in the past. When, however, one encounters strange sights and strange sounds, or even familiar objects in very unusual surroundings, he may be confused and unable to make "head or tail" out of what he hears or sees. In his effort to discover what it is, he may make a number of unsatisfactory attempts to clarify his experiences.

When an object-meaning is anticipated. Another factor which favors the organization of the sensory field in perception is expectation, or a knowledge of what one should see. In the cases of difficult perceptions this knowledge of what one should see and the desire to discover it keeps one striving for a satisfactory pattern and meaning. This sometimes occurs when one sees a picture for the first time. At the beginning nothing may be seen but an array of blacks, whites, and grays without a definite and sustained figure-ground arrangement. The individual in such a case usually tries to establish a satisfying, meaningful organization of his visual field. There is often trial and error in his efforts to see what the picture represents. If he is told what the picture represents, an anticipatory set is established which may enable him to organize his visual pattern so that he sees distinctly the object pictured. Rather suddenly the grays, blacks, and whites are assembled into a new object of perception, and the observer may wonder why he did not see it before. The stimulus-object (the picture as printed) does not change, but the individual's perceptual field is integrated into a new, closely knit pattern which clearly means a picture of that particular object.

Stimulus-pattern, organization, and learning. Since the organization or patterning of the sensory field is so potent a factor in determining clear perception, it follows that for effective learning through observation a well-organized perceptual field is important. Learning will be difficult or easy according to the observer's ability to establish a suitable and coherent configuration of the sensory materials at hand. Few persons would be able, for example, to reproduce figure 5 after one quick glance at it. Yet almost anyone could make a good reproduction of figure 6 after the briefest sight of it. There are twelve lines in each design and all of the lines are of equal length. But from one we get a poorly organized figure; from the other, a very good configuration. The design of figure 6 has a number of the features favoring good organization. The parts are similar and contiguous, but they are also balanced, and arranged in a compact, coherent form. Moreover, the pattern is familiar, and it makes sense. The parts of the other design are also similar and they are contiguous. But they are not arranged in any definite order or according to any discernible scheme. This design is nonsensical, unfamiliar, and incoherent; and it is much more difficult to learn to the point of reproduction than figure 6. A good arrangement of the learning materials favors learning.

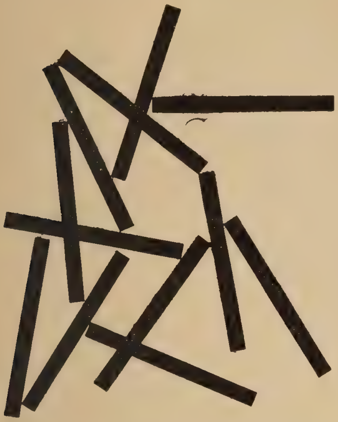

Fig. 5. A design that does not favor coherent organization. It would be much more difficult to reproduce from memory than the one shown in figure 6.

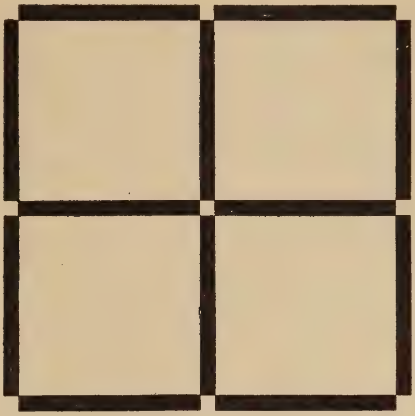

Fig. 6. A design that favors good perceptual organization. It can be reproduced easily after one quick glance.

RELATIONS AND ORGANIZATION IN VARIOUS TYPES OF LEARNING

Relations in trial-and-error learning. In trial-and-error learning of the maze or of puzzle-box sort there is the discovery of relations between various parts of the situation as experienced. In the puzzle-box demonstration described in chapter IV, when the cat first stepped on the hinged slat, he did not notice that the door had sprung open. The opening of the door was something quite detached from his act of depressing the floor slat or from his perception of the slat. But after the performance of stepping on the slat had been followed three or four times by the opening of the door, he apparently began to realize that there was some connection between his stepping on the slat and the opening of the door. It was not very clear at first just what had to be done to the slat to get the door open. This was shown by the fact that he clawed the slat, then turned his head to look at the door. When the door did not open, he lifted the slat with his paw and again looked toward the door. When this failed to open the door, he vigorously pushed down on the slat and as he turned, he saw the door had opened. There was some imperfection in the next few attempts, but the performance improved rapidly. The cat had discovered the key to the problem of escape. The slat had taken on new significance. It seems fair to assume from the subject's behavior that the slat as observed had become a new figure against a ground made up of walls and floor of the cage. For as soon as the cat entered the cage he fixed his eyes on the slat, walked directly to it, pressed it down, then turned and walked out. With the establishment of the connection between pushing down the slat and the opening of the door there came the organization of a new pattern of movements that served to bring the cat quickly to his goal without waste of effort.

The way rats perform in a maze suggests that after a certain amount of exploratory activity they gain some notion of the pattern of pathways in the maze. An orientation with respect to the goal is indicated by the fact that rats more often turn into those blind alleys which lead in the general direction of the goal than into those leading away from it (15). It has been shown, moreover, that if, after rats have mastered a maze with a long roundabout path to the goal, a change is made in the walls of the alleys providing a shorter route to the goal, they are likely to abandon the longer route and take the shortcut (4). Observations of this sort suggest that even a rat organizes the situation in a manner conducive to economical adaptive behavior.

Some writers have held that what a rat learns in a maze is a series of movements. His movement pattern does undergo a change, but, as we have noted, the rat may take various routes to his goal, and in successive runs the actual movements may differ considerably. Rats trained to run a maze were able to swim directly to the goal when the maze was submerged in water (11). It is apparent that the rat's learning in the maze involves something more than building a fixed chain of conditioned reflexes or a definite sequence of motor responses. As Woodworth (21) points out in his hypothesis of place learning, the evidence indicates that the rat learns the location of various parts of the maze in *relation* to each other. He apparently gains some degree of spatial orientation to the maze as a whole, including an awareness of the general direction of the food chamber, and relations between the various pathways and turns leading to it.

As he attempts to solve a mechanical puzzle, the human learner fumbles more or less blindly until he sees that placing two parts in a certain position in relation to each other makes possible a shift which brings the solution. Studies of maze learning with human subjects reveal more errors from entering blind alleys leading off in the same directions as the correct pathways than from entering those which lead in an opposite direction. Testimony of subjects, moreover, indicates that they soon build up a general orientation with respect to the total maze pattern. Upon moving to a new city, a man at first drives to his office over the route he is shown or over one that is marked out. But as he becomes acquainted with the general layout of the city, he may abandon this route for a shortcut or one less congested by traffic. He is able to do this because he has learned the general direction he must take in order to reach his objective.

Learning how to reach one's goal involves the apprehension of various relations. Place learning is marked by the establishment of a general orientation which includes a knowledge of the direction in which the goal lies, while in escape learning the learner observes the result to which a particular reaction leads.

Relations in conditioning. Several college students were conditioned to withdraw the right hand from an electrode at the sound of a buzzer. Then the left hand was placed on the electrode and at the buzzer signal eight out of thirteen subjects withdrew the left hand (3). In another experiment students were trained to make an extensor movement of the middle finger at the sound of a buzzer to escape shock. This was done by placing the finger on the electrode with the palm of the hand down. However, when the hand was turned over, making necessary a flexion of the finger to lift it from the electrode, ten of the eighteen subjects immediately flexed the finger in response to the buzz (20). If it were true that conditioning always establishes a particular response to a given stimulus, then here we should have had a withdrawal movement of the right hand instead of the left in the first experiment, and in the second the buzz should have elicited an extension of the finger instead of flexion. The relations of hand to electrode, of electrode to shock, and of buzzer to shock, as realized by the subjects, were decisive factors in determining the character of the response made to the CS. The goal was avoidance of shock. The reactions made to attain the goal were modified in accordance with the subjects' organization of the total situation.

It is apparent that new figure-ground relations are established in the process of conditioning. Here the learner's perceptual field is usually so organized that the CS and the UCS are experienced as belonging together and stand out as a figure set against the background supplied by the rest of the experimental situation.

Another form of relation found in conditioning is that of sign to thing signified. This is revealed in the anticipatory character of many

CR's. The CS serves as a signal to warn the subject that the UCS is about to be presented, and the activity aroused is not a duplicate of the UCR but rather a preparation for the UCS. Mateer (10) states that the children who were fed bits of chocolate after the bandage was placed over their eyes indicated by their comments that the bandage soon came to have a new meaning for them. It came to signify food. For the dog whose foot was shocked following the sound of the buzzer, the buzz became a signal that a shock was coming.

Sign learning. Learning to anticipate what is coming next is called *sign learning*. If two stimuli are repeatedly experienced in close sequence, one learns to regard the first as a signal or sign that the other is about to occur. Since the behavior elicited by the sign is in anticipation of the coming stimulus, it may be similar to or quite different from the reactions aroused originally by the anticipated stimulus. Modification of behavior results from the establishment of the sign relation. A high-school boy was studying second-year Latin. The teacher's practice was to call on members of the class to translate in the same order every day. This boy always knew when his turn was coming because the same pupils preceded him every time. So when his usual predecessors were translating, instead of following what they were saying, he was busy getting primed on the next paragraph which he knew would be his to translate. In class if the teacher regularly arises from the seat at her desk before dismissing the class, her rising soon becomes a signal that the class is about to be dismissed, and the behavior of its members shifts in anticipation of this event.

Tolman (18) holds that the important thing about learning is discovering "what leads to what." Much that is commonly called *conditioning* would be labeled *sign learning* by him. According to his sign-gestalt theory, learning is essentially a matter of establishing or altering sign relations in the "psychobiological field."

Meaningful relations and verbal learning. The learning of verbal materials so that they may be recalled, reproduced, or recited at some later time is a frequent part of classroom work. It includes the associating of items in pairs, and the rote memorizing of many items in serial order. In all its forms, the ease and effectiveness of verbal learning are dependent largely upon the meaningful relations which obtain between the items to be learned.

Take the case of complete reproduction of a series of words immediately after one reading. If the series is made up of words that are organized into an easily comprehended sentence, the learner will be able to reproduce a series two or three times as long as one made up of unrelated words. In the new Revised Stanford-Binet Tests of Intelligence a test of memory for sentences of fifteen words is placed in year XI, while a test of memory for five unrelated words is placed in year XII (16). It appears that it takes less mental ability to reproduce a sentence of fifteen words than to repeat a list of five unrelated words. It would be much more difficult to memorize a list of one hundred unrelated words than to memorize an equal number of words in a passage of prose the meaning of which is readily grasped. In chapter XIII we shall consider further the matter of meaningful relations in memorizing verbal material.

"Belonging." Thorndike has used the term "belonging" in referring to a sense of relatedness, or the meaning that one thing belongs naturally and properly to another. From the results of his experiments on the influence of frequency on learning, he concluded that mere repetition of two impressions in sequence without belonging does very little to accomplish learning; and that the greater the degree of belonging between two experiences, the greater the probability that the recurrence of the first one will be followed by the recall of the second (17). He demonstrated this principle by reading a series of twenty-four unrelated sentences six times to 200 students. After the reading the students were called upon to name the word that followed each of several words of the sentences. To the questions which called for the word that followed the last word of a sentence there were only five correct responses out of a possible 800; but in response to questions asking for the word that followed the first word of a sentence, the second word was recalled correctly in forty-two per cent of the cases. Thorndike attributed the great difference in the number of responses to these two kinds of questions to the difference in belonging. The first two words of each sentence were the first and second parts of a person's name. Here was a high degree of belonging between the terms. There was, on the other hand, almost no belonging between the last word of one sentence and the first word of the next.

In verbal paired-associates learning words are presented in pairs. Usually a series of such pairs is presented to the learner. Learning is measured by a test in which the learner recalls, if he can, the second member of each pair as the first is presented. If in such an experiment the learner encounters such a pair as *glove—hand,* he will learn it more easily than he will such a combination as *ox—arrow*. In the former the relation is familiar and meaningful. There is a high degree of belonging. In the case of the second pair there is little or no belonging except that which the experimental procedure itself provides.

Context. Shuh Pan (14) reports an experiment in which the influence of the context on the learning of pairs of logically unrelated words was studied. The results of his experiment showed the value of meaningful relations between the thing to be learned and other factors of the learning situation. They indicated that learning goes on better when these accompanying factors remain the same throughout the learning period, and that the absence of the context present during learning, or a change to a new context, at the time of recall is detrimental to recall. The removal or alteration of context, however, was found to be less detrimental in the case of thoroughly learned material than in the case of lesser degrees of learning.

Contextual relations in searching. Much of our learning activity is in the form of searching. We search for clues in attempting to solve a thought problem; the animal in the maze searches for the path which leads to food; and the child scans the map to find the answer to a study question. We learn when we come upon and recognize the object of our search.

In an experiment on searching, the writer undertook to find out how the surroundings of an object of search influence the exploratory activity and the discovery of the object (8). In the first part of the experiment a series of pictures mounted on cardboard was presented to the subjects who were told to find as quickly as possible some relatively obscure object in each one. The object to be found was always an integrated part of the search-field, definitely and meaningfully related to its surroundings. The relevant context provided many helpful leads that facilitated the search. It was a fruitful source of suggestions regarding the part of the picture where the object was most likely to be found. It served often to eliminate at the start certain sections of the picture, for one is not likely to waste much time looking for a cow in treetops or a battleship in a churchyard.

In the second part of the experiment the procedure was similar to that of the first part, except that on the cards were pasted fifty or sixty small pictures of miscellaneous objects. Since there was no relation between the search-object and its context, except that of spatial proximity or that of common membership in a field to be explored, the subject was unable to secure from the context any such clues as those which were readily provided by the relevant context of the first part of the experiment. The search in this field was quite different from looking for something in the single large picture. It was marked by systematic survey of the field, quick exploratory shifts of visual fixation, persistence of the visual image of the object sought, sketchy and obscure perception of many things merely recognized as *not* the thing the subject was trying to find, and finally a clear perception of the search-object with a realization that the task was accomplished. In most cases it required more time to find an object when its context was irrelevant than when the context was relevant.

Relations and language comprehension. *Context.* The fact that the meaning of words or excerpts from a discourse is derived to a large extent from their context is a matter of common knowledge. In speech the vocal counterparts of *to, two,* and *too* are identical. The appropriate meaning must be selected according to the words preceding and following. In many cases a printed word has a variety of meanings, and one must, to read correctly, select the proper meaning from the context, that is, by means of the other words with which it appears. A boy about ten years old looked up from a book he was reading and asked his father, "What is a groom?" The father replied, "A man who has just been married or who is about to be married." The boy hesitated a moment and spoke up again, "But this is about a horse." "Oh," said the father, "then it means a man-servant who takes care of horses." In learning to read or to comprehend spoken language the child must develop habits of responding in different ways to many words as they appear in different contexts. Almost any *sentence* contains words whose intended meaning *can* be derived only by *means* of their context. If we place the italicized words of the foregoing sentence in other contexts, their meaning is different. For example:

> The judge gave him a severe *sentence.*
> He *means* well.
> He ate a *can* of beans.

The habits of selecting the correct meaning of a word according to context are generally so well formed that one is not usually conscious of making a selection. The student of a foreign language sometimes becomes painfully aware of this problem.

What has been said of words within a sentence is equally true of sentences, paragraphs, or chapters of a book. They can be properly understood only in relation to their context. The meaning of a sentence depends to a considerable extent upon the paragraph. The paragraph is not wholly understood apart from its connections with the rest of the chapter. One cannot get the full significance of a single chapter without knowing something of the book as a whole and seeing the chapter as a part of this larger whole. The chapter to be appreciated should be read against the background of the author's aim, his particular viewpoint, and his organization of the material of the whole book.

The same thing is true of a professor's lectures in a university course. Usually, a series of lectures is planned to cover systematically a field of human experience. A visitor dropping in to hear a single lecture in the middle of the course, not knowing what has been previously discussed and without any clear notion of the general nature of the course, can only partially comprehend the discussion. For the same reason a student's attendance in his courses should be regular. The value of a well-organized course of study will be largely lost to the student whose class attendance is sporadic. He loses not only what is missed on the days he is absent, but much that he otherwise might have secured from the discussions when present.

A sentence or a remark removed from its rightful context is frequently misconstrued. A teacher in discussing the democratic form of government may present a great many points in its favor, and mention just one of its weaknesses. A child tells his parents that his teacher said a democracy is likely to be less efficient than a dictatorship; but he fails to report any of the good things his teacher stated about democracy. Then the teacher is accused of subversive teaching. Notorious examples of distortion of meaning by removing a statement from its context are seen in the way some people quote the Scriptures to prove a point. There is, for example, the story of an old preacher who did not like the way the women of his congregation did up their hair. It seems that the mode to which he objected was the winding of the hair into a knot on top of the head. One Sunday, this preacher announced as his text, "Topknot come down," and proceeded to denounce the women's hair-do with Scriptural authority. When his reference was checked, it was found to read, "Let him which is on the housetop not come down to take anything out of his house" (Matt. 24:17).

Organization of sentence elements. In the discussion of the organization of the perceptual field, it was pointed out that familiarity with certain objects of perception predisposes one toward certain configurations and that what is perceived depends upon the character of the pattern formed. In other words, past experience and training shape our perceptions. The sentence meaning we get in reading or in listening to spoken language depends on how we organize the meanings derived from the elements of the sentence; and the sequence of the printed or spoken words (stimulus-pattern) has an important influence on the way the word meanings are organized. Because of this and in the interest of mutual understanding, sentences of a language are usually cast in a customary order. In English, adjectives usually precede the nouns they modify and words of a verb phrase are usually grouped together. In other languages the customary order is different, as in French, where the adjectives usually follow nouns, and in German where certain verb forms must come at the end of the sentence. When this customary order is not followed, as in "dissected" sentences, the reader must usually put them together in a way that accords with his training, before he gets the sentence meaning. *More is material easily material than related learned unrelated.* If you stopped to make sense of the preceding group of words, you no doubt found yourself putting the words together in a new sequence and one conforming to customary usage. The clear meaning emerges when we arrange the words in the following order: *Related material is more easily learned than unrelated material.* Because of our training, the ease with which we derive the meaning of a sentence depends on the conformity of the word order to familiar usage.

In comprehending spoken language the hearer's configuration of the sentence elements is governed not only by the word order but also by inflections of the speaker's voice. In written language, the writer indicates a suitable grouping of elements of the sentence by punctuation marks. Sometimes when such punctuation aids are missing or incorrectly placed, the meaning is vague or erroneous.

Significant relations in problem-solving; insight. It has frequently been observed in learning experiments that an animal, child, or adult human subject hits rather suddenly upon the correct solution. This sometimes appears in marked contrast to the slow and clumsy process of trial and error. When a conspicuous change in a learner's method of attack upon a problem occurs in a single trial and leads directly to the solution of the problem, the learner is said to have manifested *insight.*

Although the word *insight* was occasionally used by writers before the time of Köhler's experiments with chimpanzees (1913–1917), it is to his work and his use of the term that we owe most of the present emphasis on it in the literature on learning. To Köhler it appeared that the trial-and-error feature of animal learning was due to complexity of the problem and that a better type of problem-solving procedure might be found in animals if suitable problem situations were arranged for them. He arranged and conducted many experiments in which the animals showed a rather direct approach to the solution and in which insightful behavior was attributed to the subjects. He regarded behavior as insightful when, in the face of barriers blocking any self-evident course, it leads by a roundabout path to an immediate solution. If, for example, a dog placed before a fence between a building and a short wall, sees food through the fence and runs directly back around the wall to the food instead of merely running back and forth along the fence or lunging against it, his behavior would be regarded as indicating insight.

As an example of the type of problem used by Köhler we shall describe one in which a box was used as an implement in reaching the objective. Six young chimpanzees were placed in a room on the ceiling of which a banana was fastened. The banana served as a lure. On the floor some distance from the banana was a wooden box. In their eagerness to secure the banana all six chimpanzees jumped repeatedly toward it but could not grasp it because it was too high. Now there are individual differences in learning aptitudes among anthropoids as well as among human beings, and one of these chimpanzees, whose name was Sultan, seemed more apt than the others in solving problems of this type. Sultan at first tried leaping toward the banana as did the others. Soon, however, he ceased his jumping and paced back and forth across the room. Then he stopped for a moment in front of the box. Quickly he moved it over under the banana, climbed onto the box, and then jumped from this point of vantage to secure the fruit. Sultan seemed to grasp the situation in such a way as to bring the box into relation with the banana. From the moment of his hesitation before the box his behavior showed unified and continuous action adapted to securing the banana (9).

In the case of experiments with animals and children, the term *insight* should be understood as referring to the character of the behavior employed in reaching the goal or solving the problem. It is commonly contrasted with trial-and-error behavior. Insightful behavior is marked by an attentive survey of the problem situation. Sometimes the animal halts his precipitous and miscellaneous assault and, after deliberately sizing up the situation, proceeds directly to the goal or to the solution by a well-ordered series of appropriate responses. During the course of insightful behavior the attention is persistently or recurrently fixed on the objective. Once the problem is successfully solved by the aid of insight, the adaptive behavior is readily repeated. In the case of crude trial-and-error learning, the situation is not mastered when the successful reaction is first accomplished. The succeeding trials are still full of trial and error. The successful reactions are differentiated only gradually and mastery comes only when, and in so far as, the learner discovers the relation of the successful responses to the solution of the problem. Insight implies that the animal grasps this relationship at once, or at least in a comparatively few trials.

A child one year and nine months old was shown a toy music box. His interest in it and attention to it were instantly aroused. Then the toy was placed beyond his reach on a table. He tried reaching for it a few times but failed. A stick was handed to him. With this stick it was possible for him to pull the toy within his grasp. But at first he seemed to see no connection between the stick and obtaining the box. He shifted his attention to blocks on the floor, and started toward them. The experimenter called his attention to the stick again by jiggling it on the table near the toy. When the child saw the stick and the toy at the same time, he took the stick, and, using it as a tool, pulled the music box toward him so that he could seize it in his hands. Insight came the moment he saw a connection between the stick and the toy. His perceptual field took on a new form of integration; the stick took on new significance (2).

The writer observed a five-year-old child trying to get his coin bank from a plate rail high up on the dining room wall. He climbed into a chair and reached for it, but it was about six inches beyond the tips of his fingers. He paused a moment, ran into the living room, picked up a small hassock. He brought this back, placed it on the chair, mounted the chair, and then climbed onto the hassock. From there he seized the bank and descended with it in his hand. This case resembles in many respects the box problem used with apes, mentioned above. There is one important difference. The child showed insight more quickly than the best of the apes. He was able to bring the hassock into relation with his objective even when it was not within the range of his vision. He remembered or thought of the hassock, and the idea of it was incorporated into the total situation. In the case of human learners, at least, insight may be achieved through memory or imagination. In very young children and animals the ideational element is presumably meager or entirely lacking, and the relations which provide insight are apparently those found in the organization of the perceptual field.

Since with insight one learns more quickly and with less waste of energy than by the trial-and-error method, teachers should foster insightful learning in children. The child can and should be helped to discover significant relations in learning situations. A teacher speaking of a child six years and ten months old stated that in his arithmetic, "He frequently showed insight that gave him shortcuts to his answers, as for instance when he said, 'Nine and nine are eighteen, so nine and eight must be seventeen.' "

In order to foster insight we must understand what favors it and under what conditions it is most likely to appear. In the first place, the experimental observations indicate that a careful survey of the whole situation is essential. When all the elements of the problem situation are not considered, crucial relations may not be discovered, and the learner in failing to find these tends to resort to exploratory manipulation, or trial and error.

In the second place, previous experience and training have much to do with insight. Even the ready apprehension of relations between factors of the perceptual field is influenced very much by previous experience. This is demonstrated by an experiment conducted by the Kelloggs. It was called the *hoe experiment*. The problem was to pull within reach a piece of apple by means of a small wooden hoe. The subject was a fifteen-months-old child. The apple was placed beyond a wire screen, and at first directly in front of the blade of the hoe. In this position the child readily drew the apple in by pulling on the handle of the hoe. But when the apple was placed a little to one side of the hoe's blade, it took 337 trials with demonstration and guidance to enable him to reach the learning criterion of four unassisted successes in five attempts. The results indicate that for this child of fifteen months this was a very difficult learning problem. Experiences of many sorts would have made it apparent at once to an older child or adult that to get the apple it must be in front of the blade of the hoe when he pulls. But this child's experiences with mechanical relations were so meager that he just could not see how to do it (6). Many such observations with animals and children point to the conclusion that the degree of insight which an individual is able to employ in solving a problem depends upon his age, his intelligence, and his previous training.

As a problem becomes more involved or as it transcends the range of previous experience, the learner is likely to show less insight and more trial and error. Most apes can solve fairly quickly the simple problem of using a short stick to reach outside a cage and rake a banana within reach, or of pulling on a string to secure food tied to its opposite end. But the problem of putting a box in place to secure food is more difficult. It usually involves considerable trial and error before insight appears. When the problem is one of stacking one box on top of another, a great amount of experimenting and manipulation is likely to take place with success coming only to the more able subjects.

Thus, trial and error is not always divorced from insight. In many concrete cases of problem learning they both appear. In some cases trial and error is more conspicuous; in others, insight may lead to success in the first trial. Sometimes after a great deal of trial and error the learner seems to come suddenly upon the solution and then reacts correctly on the succeeding trials. Insight and trial and error often go hand-in-hand, appearing in varying relative amounts. The degree to which each appears seems to depend upon the difficulty of the problem for the subject, and for a given problem, upon the experience, training, age, and intelligence of the subject. Insight does not mean discontinuity with the past, nor does it mean simply the possession of past experiences. It does mean the appropriate organization of experience to meet the requirements of the new problem situation.

EDUCATIONAL SIGNIFICANCE OF RELATIONS AND ORGANIZATION

The general principle which we have been considering in this chapter is not a teaching device nor a rule. It does, however, represent a fundamental aspect of all learning, and for that reason it has many far-reaching implications for education. It is of concern to the teacher both with respect to those relations which obtain as the pupil approaches the learning situation, and with respect to those which need to be established in the interest of successful learning. The effectiveness of teaching depends largely upon the ability of the teacher to recognize and utilize those relations which already exist, and to secure the establishment of those which are needed.

For understanding the child. Good teaching calls for an understanding of child nature, because the nature of the child, including all that he has already learned, determines how he reacts to the learning situation. There are many sorts of relations involved here which must be recognized if the teacher is to understand the child.

First and most fundamental are those relations involved in the conception of the child as a total organism. With all the various traits organized into a unified whole, no one trait or part can be truly understood unless its connections with the others and its place in the whole are recognized. Thus, intelligence does not exist apart from the social, physical, and emotional traits, and it can be properly judged only when its relations to them are considered. The tester of intelligence goes astray if he fails to see when the child's test performance is impaired by fear, ill health, or resentment. An individual's emotional behavior is likewise understood only in relation to intelligence, social traits, and physical conditions. A temper tantrum in an imbecile or young child does not have the same significance as a tantrum in an adult of normal intelligence. To be understood the child must be seen as a total personality in which each part is what it is because of its place in the total pattern.

Furthermore, the relations of the child to his social and physical environments are to be taken into consideration. An individual is what he is because of his heredity, previous experiences, training, and his present relations to other persons in the school, the home, and the community. The child is understood only when we take into account his position in the family, his gang membership, and his church affiliation. The adolescent is understood only in the light of his childhood, the traditions and ideals of his community and school, and the state of the nation and the world. When we consider that learning is derived from activity and that activity depends upon the nature of the learner as well as upon the stimulating situation, it is seen that the ramifications of the conditions of learning are numerous and far-reaching.

For teaching practices. It is to be borne in mind that relations are connections realized by the learner and that organization refers to the manner in which the learner organizes his own experiences. Thus, in the preceding section on understanding the child, the relations mentioned are those to be recognized by the teacher as a learner. We now turn to the child as the learner. The teacher's task is to help the child see significant relations and so to manage the instructional situation that the child will be able to organize his experiences into effectual functional patterns.

The teacher does not organize the child's experiences nor does he establish relations for him any more than he learns the child's lesson for him. But in verbal explanations, showing pictures, putting words on the blackboard, presenting reading matter, and in many other teaching activities, he is arranging and providing stimulating situations. Now since the stimulus-pattern may and often does determine the character of the experiential configuration, it follows that the arrangement of the subject matter and materials of instruction, and the order in which they are presented will affect greatly the child's observations, his comprehension, and, in general, his learning.

For this reason careful lesson planning, with due regard for suitable arrangement and orderly presentation, is essential for good teaching. Practices conducive to the establishment of appropriate relations and organization include: starting with the familiar, basing each step on those already taken, putting together facts which belong together, grouping items according to their natural connections, placing subtopics under the topic to which they belong, using illustrations based on the learner's experience, giving major emphasis to essentials, centering supporting details around the main points, and avoiding irrelevant details.

Furthermore, effectual classroom learning requires the integration of all the divisions and topics of each subject. Previews, outlines, and reviews reveal relations between the various parts of a subject and promote the organization of a subject as a whole. When a reader begins a new book, an examination of the table of contents will often provide a degree of orientation which facilitates comprehension because it helps him to see each part in relation to the whole.

As the material of each subject should be organized into a coherent whole, so also all the various subjects of a course of study should be integrated. As reading should be tied to spelling, arithmetic, and the social studies, so, also, every subject should be related to all the others. Projects or activity units which call for the use of reading, writing, spelling, arithmetic, geography, and oral expression in a single undertaking, provide excellent opportunities for binding together the substance of different subjects.

Moreover, for a satisfying conception of life and the world all of one's knowledge needs to be harmoniously and meaningfully organized. The young child's world may not be the world of the adult scholar, but it can and should be unified by means of meaningful relations. A teacher wrote the following account of the way a six-year-old boy organized his world:

> I have seen him exude quiet satisfaction and content when the knowledge dawned upon him that he is a part of the universe, that there are other children on the other side of the world just like him, that when we have day they have night, because the earth turns around on its axis, and shows a different face to the sun at different times of day; that the earth also revolves around the sun making our seasons. And that the moon has her orbit and all the stars theirs. All are connected in God's plan, and all have a common source of life and movement. He was satisfied. Everything that had bothered him at the moment had been organized and he could go on to other problems (5).

Given a suitable arrangement of the materials of learning, pupils will often be able to see for themselves relations which give meaning and coherence to their study. There will be many cases, however, where additional assistance from the teacher will be needed. This may be provided in many ways, such as making comparisons, discussing the causes and effects of events studied, classifying, and conducting drills in realistic situations. The learning of history may be made effectual by relating it to present conditions. Physiology is better understood when the pupil realizes the interdependence of bodily functions and their importance for his own health. Arithmetic becomes more meaningful when the learner sees its connection with practical everyday problems. Spelling is learned better when the words are written in sentences than merely by writing a list of unrelated words. Defining words makes it easier to learn the spelling of them, and practice in writing real letters is a good way to learn to typewrite (1, 12).

In the case of long and difficult material, outlining may help the student put the various parts in their rightful place. For immature students the teacher may have to supply the outline or assist the students in making one. Good study guides or study questions which point to significant relations may serve as valuable aids. While the teacher must provide help to most pupils, particularly at the beginning of any subject, he should diminish direct aid as rapidly as possible. The mature student should be able to take up a subject, formulate pertinent questions, and seek for their answers without assistance. If he is able to do this, he can study independently. When one knows the right "learning threads" for any field of investigation, he can take up systematically one division after another until he is thoroughly acquainted with the whole subject (13, 19).

SUMMARY OF THE CHAPTER

The theme of this chapter is the importance for learning of meaningful relations and organization. By a *relation* is meant the bearing which one thing has upon another, or any kind of connection which exists between two things, which is recognized by the learner. Organization is founded on relations.

In perception we have the organization of the sensory field into figure and ground pattern. The patterning of this field is an important determiner of meaning. Success in trial-and-error learning comes from the discovery of the relation of some object or movement to the goal. In conditioning experiments the CS frequently serves as a sign or signal that the UCS is soon forthcoming, and because of this it arouses anticipatory behavior. In sign learning we have the setting up of a relation whereby one thing indicates what is coming next, or through which the learner discovers "what leads to what."

In learning verbal material in sequence, repetition accomplishes very little except as there is the relation of belonging between the items to be learned. It is much easier to memorize meaningfully related material than unrelated material. Insight is the more or less sudden grasping of relations between certain elements of a problem situation which leads directly to the solution of the problem.

Learning is influenced to a considerable extent by the context, by the setting, or by the surroundings of the items to be learned. Relevant contexts facilitate learning. The meaning of a word or a sentence is determined largely by its context. The meaning of a sentence depends in part upon the way the words are grouped within the sentence.

The principle of relationship and organization has many practical implications for teaching. The child can be understood only as a total organism and in relation to his heredity, his past, his future, and his present social and physical environment. The teacher may assist the child to organize his experiences by the way he presents the materials of learning. Reviews, previews, drills in realistic situations, stressing connections between topics, outlining, and furnishing study questions are some of the ways a teacher may help a child or student to relate and organize his experiences for the effective mastery of subject matter.

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PART III

IMPROVEMENT, THE LEARNING CURVE, AND PHYSICAL HANDICAPS TO LEARNING

CHAPTER IX

THE COURSE OF IMPROVEMENT

The purpose of teaching is to secure improvement of performance. This improvement includes an increase in proficiency in any of the school subjects, and also the achievement of better conduct and greater facility in the activities of life beyond the classroom. Unless we secure improvement, we are not successful as teachers. We need, therefore, to consider the course of improvement, its limits, and factors which affect its rate.

THE LEARNING CURVE

A convenient means for depicting progress in learning is the learning curve. This is a graph which affords a comparison of the performance on each trial with the performances on the other trials. In order to build such a graph, the successive trial performances must be scored in some way. In studies of learning, several different methods are used to measure performance. Action skills are usually measured in terms of speed and accuracy. Speed may be measured by recording the time required to complete a given task, or in terms of the amount done in a given length of time. Accuracy is scored in terms of the number of errors made in each trial, or by the number of successes in a given number of attempts. Serial verbal learning is measured in terms of the number of items one can reproduce after a given number of presentations, or the time or number of presentations required to learn to the point of complete mastery.

Constructing the curve. When the scores from a series of trials or tests are secured, a learning curve may be constructed that will show graphically the course of learning. In constructing a curve, we first draw two straight lines, a perpendicular one at the left side of the page, and a base line which extends horizontally to the right from the bottom of the first. On the perpendicular line a scale is marked off and numbered with units suitable to the size of the scores. The units of the scale must be equal and the range great enough to cover the largest score. Since scores are usually arbitrarily defined and since for different measures they vary greatly in magnitude, the number of score points represented by a given section of the vertical line is a matter of convenience to be determined by the size and range of the scores and the desired shape of the graph. The units of the scale are numbered from the bottom upward. The successive trials are indicated by number along the base line at equal intervals from left to right. Next, a point is located directly above each trial number. The distance of each point from the base line is equivalent to that of the point on the vertical scale which corresponds to the score for that trial. Then these points are connected by straight lines. The lines connecting the points constitute the curve of learning. It shows at a glance how the learner has progressed from trial to trial.

An example of a learning curve so constructed is shown in figure 7. The scores are taken from an experiment in which the subject was required to learn the English equivalents of ten Hebrew words. The experimenter first read the Hebrew word and gave the English equivalent. In the following trials, after reading each Hebrew word, the experimenter paused and the subject gave the English word if he could remember it. If he could not do so, he was told what it was, and then the experimenter proceeded to the next word. The score on each trial was the number of correct responses. The criterion of learning was three successive trials in which all the right English words were given. The scores for the fifteen trials were as follows:

Trial:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score:	0	1	3	2	2	4	4	4	5	5	7	9	10	10	10

Since the highest score was ten, the scale is made up of ten equal units numbered from bottom to top. Each unit of the scale represents one score point. The fifteen trials are represented from left to right on the base line. The height of the curve above the trial points indicates the score for each trial.

Figure 8 shows an arrangement of the scale to represent larger

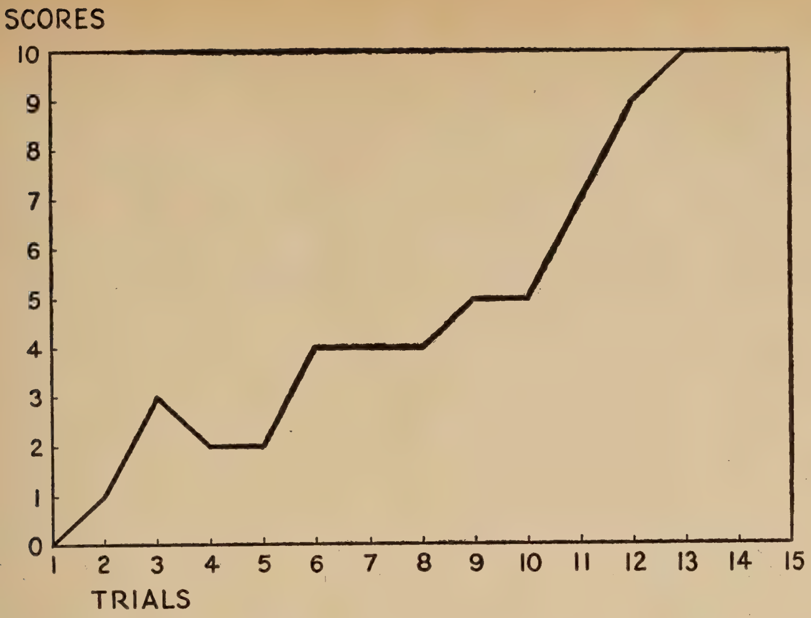

Fig. 7. Learning curve showing improvement in ability to reproduce the English equivalents of Hebrew words.

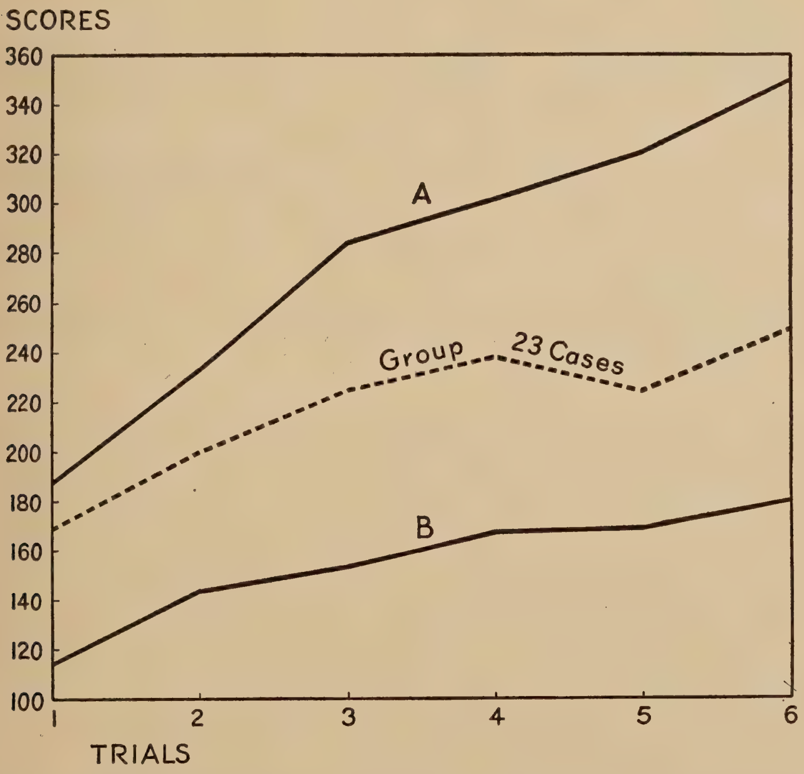

Fig. 8. Curves of learning in a digit-symbol experiment. The subjects were given a sheet containing the digits and were instructed to write, as rapidly as possible, a symbol under each digit, as indicated by a key. The scores are the number of symbols written during a practice period of five minutes.

scores, and in this graph three curves are presented. A and B are curves of two individuals, and the middle one represents the average scores for twenty-three students. The scores of A and B are included in the averages used to construct the group curve. It is possible here to compare the progress of the two individuals with each other and with the average of the whole group. We see that A was faster than the group average on the first trial and that she gained more with the same amount of practice. We see also that she did not fall back on trial 5 as did most of the group. The lower curve shows that B started off more slowly than the average, and while she gained at about the same rate, she is approximately as far behind after six practice periods as at the end of the first period. If, in classroom learning, a whole class dropped as did this group in trial 5, a graph charting the progress of the class would reveal it at once. An alert teacher would try to discover the cause and prevent its recurrence.

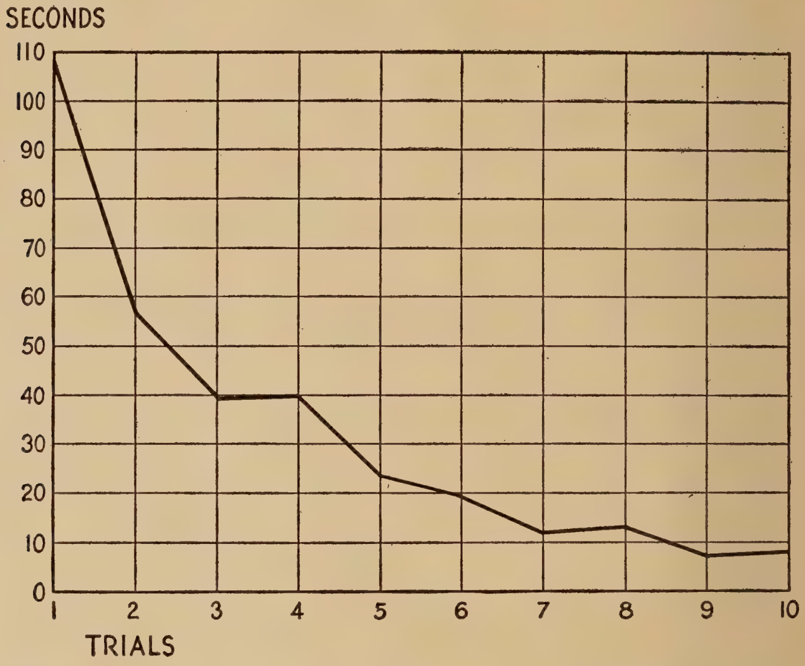

Fig. 9. Learning curve from a puzzle-box experiment. The scores show the mean time required by a cat to escape from the puzzle box in each of ten successive sessions. In each session the cat escaped from the box ten times.

In cases where progress is indicated by a decrease in scores, the curve starts high up on the vertical line and drops as improvement is made. Such a curve is shown in figure 9. Here each trial score is the average time in seconds taken by a cat to escape ten times from a puzzle-box. Each trial was a session of ten successful escapes. The times for individual escapes varied greatly owing to the chance factors, but when the average time for each session is plotted, we see how the cat improved her performance time in a total of 100 escapes.

The rate of improvement. One of the things a learning curve reveals is the rate of improvement and the changes in this rate. A uniform rate of improvement is indicated by graphs of the type shown in figure 10. Here progress is indicated by a straight line. Such a graph means that the increment of gain is the same for each successive trial. When the rate of improvement shows no change, we have what is known as *zero acceleration*. In most cases there is a change in the rate of improvement. In many cases, however, we get a close approximation to zero acceleration. In an experiment suggested by Jordan (8), the subjects were asked to name the letter of the alphabet falling midway between two given numbers. Each number represented a letter of the alphabet determined by numbering all the letters consecutively. There were twelve practice periods of three minutes each with one-minute intervals between.

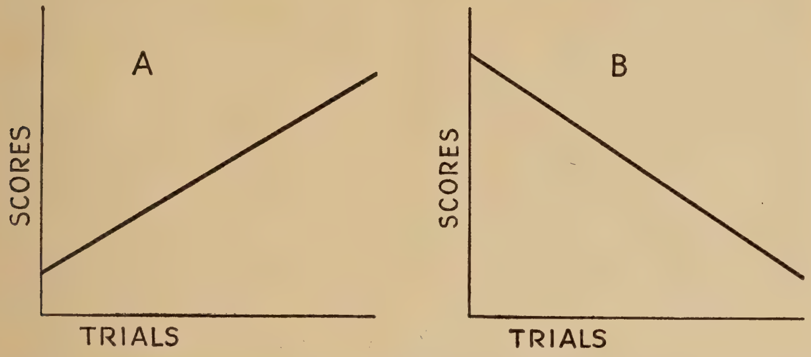

Fig. 10. Theoretical learning curves showing zero acceleration or a uniform rate of improvement. In *A* improvement is indicated by an increase in scores. *B* represents those learning situations wherein decreasing scores mean improvement.

Figure 11 is based on the average of the scores for each trial made by a group of thirteen students. It shows a curve which approximates zero acceleration. The rate of improvement was not perfectly uniform, being a little faster from trial 1 to trial 5 than from trial 5 to trial 10.

Most curves of learning show variations in the rate of improvement. Curves for motor learning usually show the fastest rate of gain at the beginning and a slowing up as practice continues. Such a change in rate is called *negative acceleration*. It should not be confused with a loss of skill. It refers to those cases wherein improvement is still being made, but the increment of gain decreases in successive trials. Theoretical curves for negative acceleration are presented in figure 12. An example of negatively accelerated curves based on actual learning scores is shown in figure 13. It will be noted that in the case of negative acceleration the upward curves are convex in form.

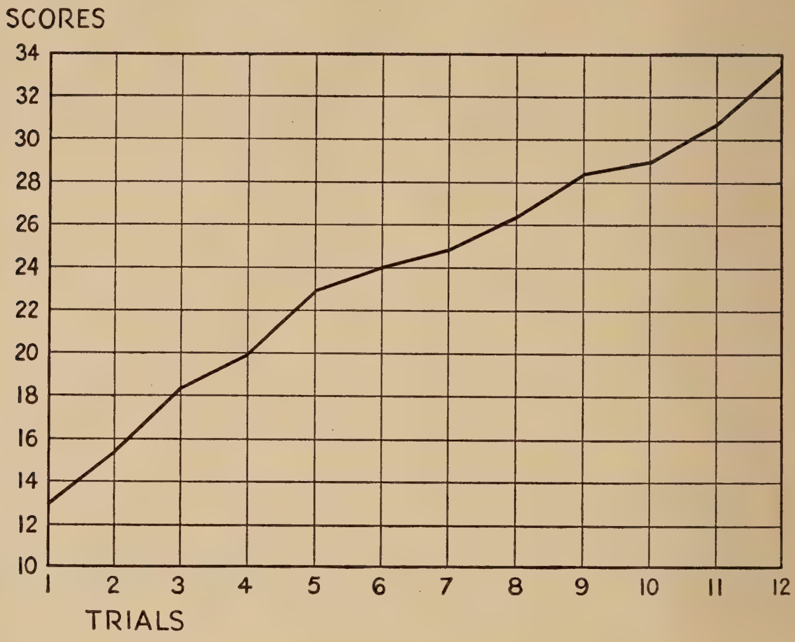

Fig. 11. A learning curve that approximates zero acceleration. Scores are the trial means for thirteen subjects. The task was to name the letter falling between two other letters of the alphabet designated by numbers.

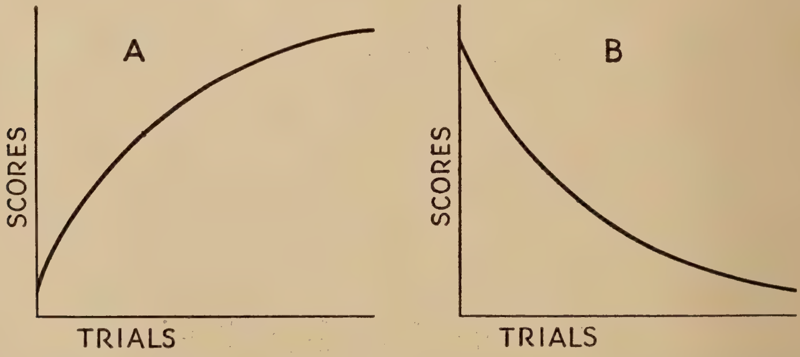

Fig. 12. Theoretical curves of negative acceleration. The curves show a decrease in the rate of gain.

In the cases in which the scores grow smaller as performance improves, negative acceleration is indicated by a downward concave curve.

Figure 14 presents a graph showing negative acceleration of improvement in a card-sorting experiment. From a regular deck of playing cards the face cards were eliminated. The cards were thoroughly shuffled. Four compartments were arranged, one for each suit. The subject's task was to sort the cards into these compartments as rapidly as possible according to the following scheme. The first card was thrown face up into the heart compartment. The compartment into which the next card was thrown was the one corresponding to the suit of the first card thrown. If the first card were an ace, then the second card was thrown face up into the ace compartment. If this card were a diamond, the next card was thrown into the diamond compartment. Each trial consisted of sorting the 40 cards according to this procedure. The time for each trial was recorded in

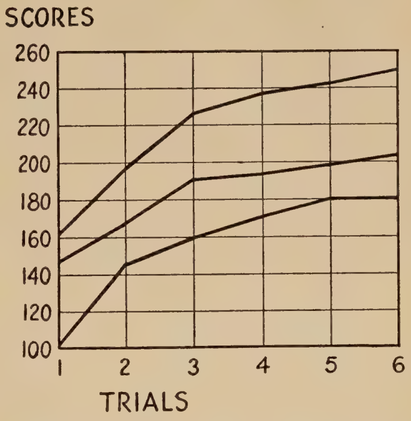

Fig. 13. Negatively accelerated curves for three individuals. They represent the number of symbols written under numbers according to a key, during six consecutive practice periods of five minutes each.

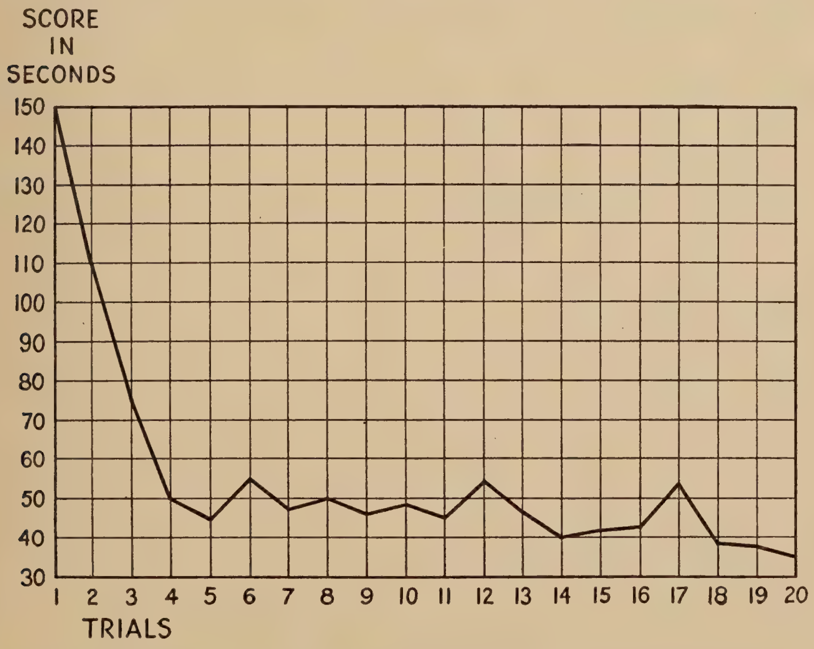

Fig. 14. A downward curve of negative acceleration. Scores are the number of seconds required by the subject to sort a deck of forty cards in a prescribed manner.

seconds. The curve in figure 14, based on the scores of one subject, shows rapid improvement through the first four trials. Then follows an irregular course with slight gain in the fourteenth trial, and, after a setback, slight additional gains in the last three trials.

Sometimes there is very slow progress at the start with an increase in the increments of improvement as practice is continued. This increase in the rate of improvement is called *positive acceleration.* Upward curves of positive acceleration are concave in form while the downward curves are convex. Such curves have been found in learning to solve mechanical puzzles (3*a*), and in various forms of informational learning. Swift (12) reports a curve of positive acceleration in an experiment on ball tossing. Each trial consisted of catching and throwing one of two balls while the other was in the air until the subject missed one or both balls. The curve showed slow progress at first and faster improvement in later trials. Positive acceleration in the rate of improvement in speed of silent reading is reported by O'Brien (10). In figure 15 is shown the form of curves where the acceleration is positive.

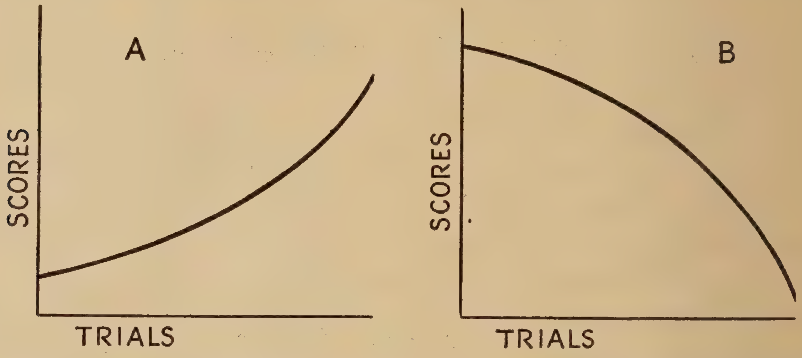

Fig. 15. Two theoretical curves of positive acceleration. In both the rate of improvement is faster in the second half of the learning period than in the first part.

Individual differences appear in the forms of curves when several subjects are working at the same learning task. In the experiment on learning the English equivalents of Hebrew words mentioned above, while the curves of most of the subjects showed negative acceleration, a few showed positive acceleration. Figure 16 is the curve for one subject. This curve shows the progress made, by the prompting method, in learning the meanings of ten Hebrew words. It will be noticed that while at the end of ten trials she was able to give in English the meanings for only five of the words, she gave them for all ten on the thirteenth, fourteenth, and fifteenth trials. The rate of advance was approximately twice as fast in the last five of the fifteen trials as during the first ten. This positive acceleration appeared when the subject learned by hearing the words read to her. Her progress showed negative acceleration when she learned by reading the words from cards, and also in another series in which she read the words and also heard them pronounced by the experimenter. In these two series the subject responded to the Hebrew word as she saw it presented on a card without the English word. In a fourth series the subject also read and heard the words but responded to the spoken Hebrew word, and in this series her learning showed zero acceleration. It seems that the form of the learning curve may vary not only for different individuals learning the same material in the same way, but also for the same individual learning the same material in different ways.

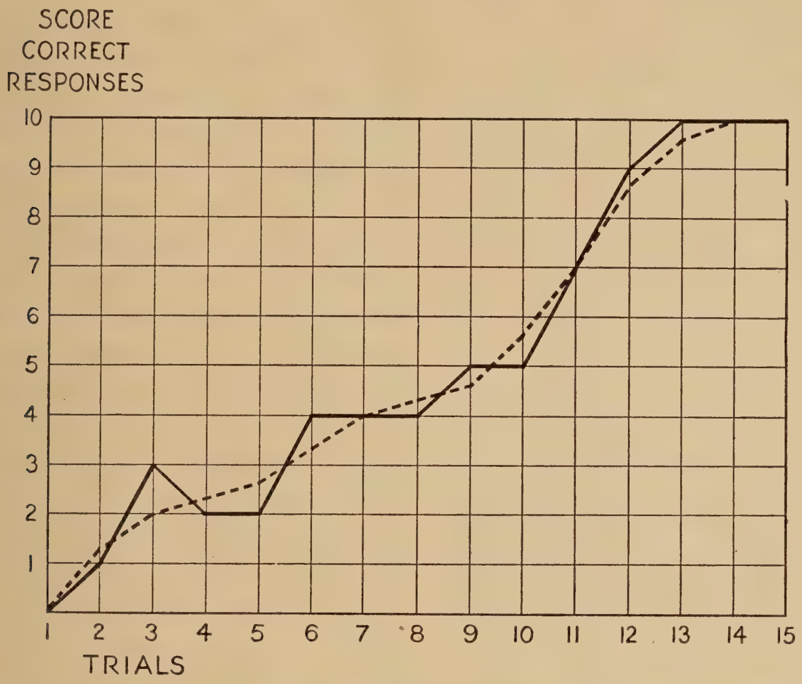

Fig. 16. Curve of learning the English equivalents of Hebrew words that shows positive acceleration. The solid line presents the actual scores. The dotted line is a smoothed curve based on these scores.

An example of positive acceleration is found in the increase of children's vocabularies during the second year. In an investigation by Smith (11), the average number of words in children's vocabulary at one year was found to be three words. For children fifteen months old an average of nineteen words was found. At eighteen months old there was an average of twenty-two words. But by twenty-one months, ninety-six more words were added, and at the end of the second year the average was 272 words. Thus, the increase during the second six months of the second year was found to be 250 as against an increase of nineteen for the first half of the year. These findings are presented graphically in figure 17.

It is clear that positive acceleration cannot continue indefinitely, for sooner or later the learner reaches complete mastery, or the curve levels off as he approaches the limit of his ability to improve. Which of these two possibilities takes place will depend upon the nature of the learning task and the manner of scoring the performance. In many cases a rate of learning that is positively accelerated at first changes to negative acceleration as it continues. This provides an S-shaped curve, examples of which are shown in figures 18 and 19. Figure 18 shows several variations in rate of improvement but its general form indicates increasing rate in the first few trials, followed by a slowing up. In figure 19 the increments of gain increase through the fourth trial and then occurs an abrupt leveling off.

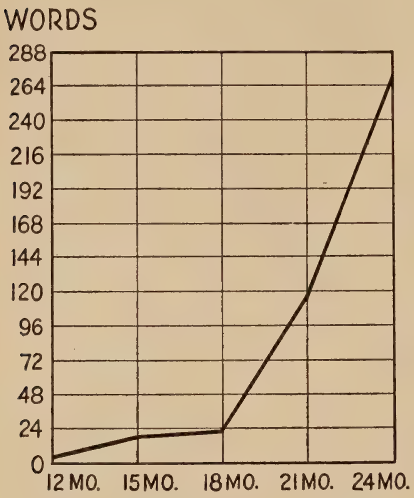

Fig. 17. The increase in the average number of words in children's vocabulary during the second year. The curve for this period is positively accelerated. Constructed from data by Smith (11).

It is likely that if we were able to plot a complete learning curve from zero to the absolute limit of improvement for any single performance, we should find the S-shaped curve with relatively slow progress at first followed by increasing increments of gain and a leveling off with decreasing gains as the limit is approached (6). It may be presumed that a very rapid initial rise in a learning curve is due to the fact that the learning task is not altogether new to the learner and that he does not therefore begin at a zero point. Initial ability may make some aspects of the total performance easier to master than others. If these easier steps have a direct effect on the score, there will naturally be rapid improvement as indicated by the method of scoring. The harder steps are not mastered so quickly; therefore, the apparent progress becomes slow after the easier initial gains have been accomplished.

The increase in the rate of improvement, or positive acceleration, may be due to the fact that the results of practice are cumulative in their effect on the score. Much of the early practice may be a kind of preparation that makes possible the more rapid advance later. Various aspects of the total performance may be undergoing improvement with comparatively little effect on the score, and then when they are being integrated and consolidated, the curve rises more rapidly. Faster

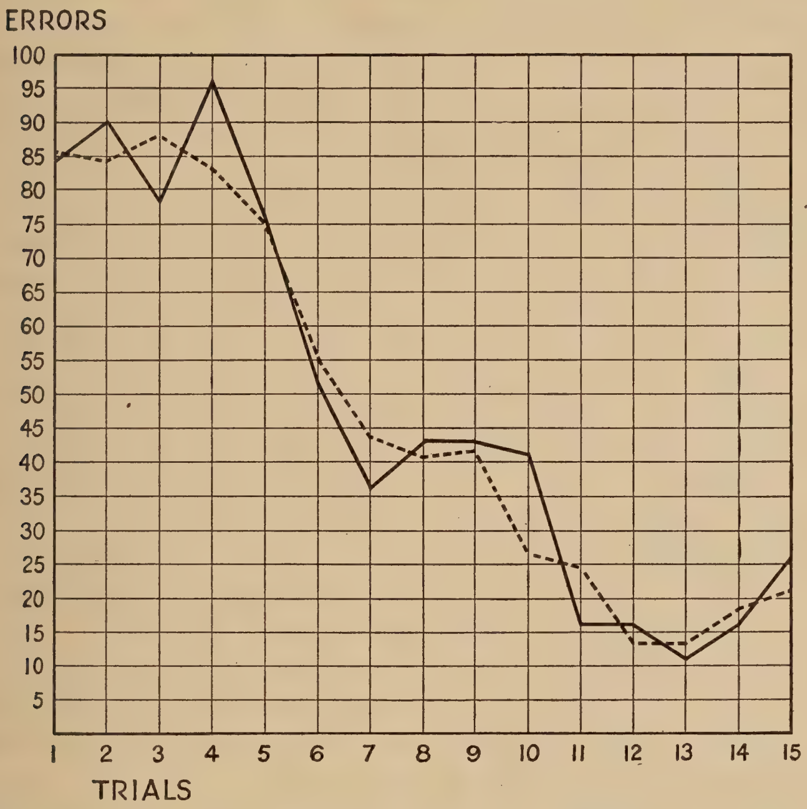

Fig. 18. Learning curve that shows positive acceleration in the early stages and negative acceleration near the end. The scores are for one subject. They represent errors made in tracing a star outline while looking at its image in a mirror. The solid line is the actual curve. The dotted line is the same curve smoothed by the method of averages.

progress may also come with new insight or with the mastery of tools of learning. In a first course in science the progress may be slow at the beginning while the student is becoming accustomed to the terminology of the new field and to the insistence of science upon exact data. After a difficult period of adjustment to new points of view, new methods of study, and new vocabulary, he becomes oriented, acquires confidence, and then goes ahead at a faster pace. When the results of learning in the early stages of practice or study contribute to and make easier the advancements in the later stages, positive acceleration occurs.

The slowing down of the rate of improvement may be caused by several factors. In some cases part of the effect of continued practice may be consumed in maintaining gains already achieved. As learning advances, this tends to be true to a progressively greater extent. More and more of one's practice is required to keep the performance up to the level of efficiency already attained. Then too, as the limit of improvement is approached, it takes more effort and time to secure an increment of gain. This would cause a slowing down. There are also the influences of such factors as fatigue, loss of interest, a sense of sufficiency, lack of desire for further advancement, and the needless repetition or overlearning of parts of the performance mastered in the early steps of learning. These are some of the varied factors which may produce negative acceleration of the rate of improvement.

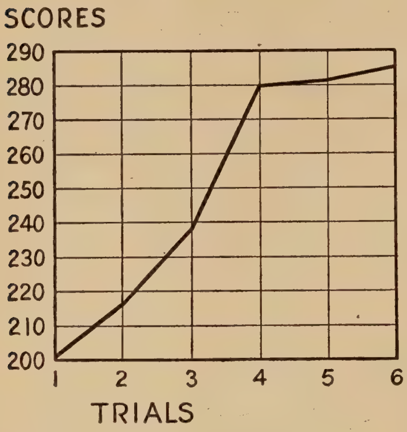

Fig. 19. Learning curve showing positive acceleration during first trials and negative acceleration in later trials. Scores are from the performance of a single learner in an experiment on digit-symbol substitutions, each score being the number of symbols written during a practice period of five minutes.

Plateaus. Frequently one finds in a learning curve a level stretch in which the scores remain very nearly the same through several trials. It appears from the scores that no advancement is being made even though practice seems to be going on as usual. Such level stretches of the learning curve in which there is no apparent progress are known as *plateaus.*

Plateaus of learning were observed and described by Bryan and Harter in experiments on learning to receive and send telegraphic messages (4, 5). They pointed out that the acquiring of a complex skill like sending or receiving in telegraphy involves the establishment of a hierarchy of habits. First come those simpler habits involved in receiving or sending one letter at a time. After proficiency is gained at this level, the learner passes to higher units of response in which combinations of letters such as *tion,* or *con,* or simple words as *the* or *his* are organized into higher functional units. Bryan and Harter suggested that plateaus represent periods in the course of learning where the lower order of habits are being thoroughly organized and established. This mastery of the simpler habits, they believed, was necessary before the learner could pass on to higher units of performance. On this assumption they concluded that plateaus were an essential feature of all complex learning.

Book (2) found plateaus in the curves of learning typewriting. But his findings and conclusions were not wholly in accord with those of Bryan and Harter. He observed a definite slump in interest and effort at those points in practice where the plateaus occurred, and suggested that these slumps may be a part of the cause of the plateaus. He also noticed that learners sometimes successfully attempted the higher-order units of response before the lower-order habits had been fully established. When these higher units of action were attempted, there were usually many mistakes in writing that caused discouragement and loss of interest. Book believed that the rise in the curve following a plateau was occasioned by the passing to a higher-order habit, but he held that the continued improvement of the lower-order habits contributed to such a rise. He maintained that these lower-order habits can best be established by practicing them in writing sentences. He also found that the increase in skill following a plateau was to some extent the result of an improved attitude and increased interest on the part of the learner. While Book noted that plateaus were connected with the passing to a higher unit of performance, he held that they are not necessary because many learning curves do not show them at all, and that the causes of these slumps can be removed if the right kind of help is given to the learner (3*b*).

Other investigators have pointed out that since plateaus are more likely to occur in complex performances than in simple ones, they may be due to the fact that the learner concentrates on one part at a time. It is suggested, therefore, that if the learner attacks the whole performance as a unit, he is more likely to make steady and continuous progress (1, 9). In a performance measured for both speed and accuracy we may get a plateau in the reduction of errors when the subject sets himself to improve his speed. If he suddenly decides to concentrate on accuracy, his curve of speed may show a plateau.

In general, it may be concluded that plateaus are caused by several different factors. They may be due to concentration on one part of a complex performance; to the fact that the learner is doing as well as he can for the method he is using; to imperfectly established elementary habits; to poor physical condition; or to factors of attitude or set of the learner, such as loss of interest, discouragement, or divided attention. Since most investigators are inclined to believe that the plateaus are not a necessary feature of learning progress, the teacher should be on the alert to detect any slumps in classroom learning. When they occur, an attempt should be made to discover the cause and help the learner to resume his progress. The teacher should see that the child has mastered the necessary steps for advancement, promote the adoption of better methods of work, overcome loss of interest and reduced motivation by new and appropriate incentives, remove discouragement by helping the child master his difficulties and by the legitimate use of praise, take measures to prevent carelessness, and endeavor to secure practice on the performance as a whole.

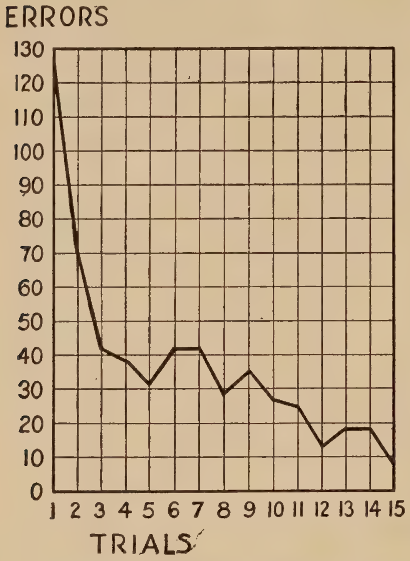

Fig. 20. Learning curve showing the number of errors made during each trial by one subject in the mirror-drawing experiment.

Minor fluctuations in the learning curve. A learning curve seldom rises smoothly from trial to trial. While the general trend may be upward (or downward), there is frequently a great deal of zigzagging. Figure 20 shows the fluctuations in a curve for errors in the mirror-drawing experiment. The task was to trace the outline of a six-pointed star while looking only at the image of the star in a mirror. The star outline consisted of parallel lines one-eighth inch apart. The subject was instructed to trace between the lines. An error was defined as touching or crossing either line.

Figure 21 shows the fluctuation in the progress of a learner seeking to reduce his time for sorting forty cards into four compartments. As each card was thrown, its suit was noted, and the next card was thrown into the compartment marked for that suit. The curve is based on the time required for each of twenty sortings. It is to be noted that the subject's progress is marked by numerous setbacks and spurts.

A number of factors affect progress in learning. Some of them tend to better the score, while others operate against improvement. The combinations of these factors vary from trial to trial, and fluctuations in performance result from the variations. With diligent effort and good attention, one makes an excellent score. Then on the next trial he does not do so well because the combination of conditions at the time are not so favorable. A temporary setback may result from poor attention. The learner may be distracted by a noise or by the movements of another person. He may reflect for a moment on how well he is progressing and may perhaps grow a bit careless or relax his effort because of overconfidence resulting from his previous good score. It may be fatigue which in the following trial is offset by adopting a different posture. Possibly these variations in performance are related to other changes in organic conditions. Upon seeing that he has not done so well the learner sometimes renews his effort and applies himself more diligently the next time. As he does so, his performance reaches a new high. So he goes on, occasionally slipping back, but again advancing to higher levels of proficiency.

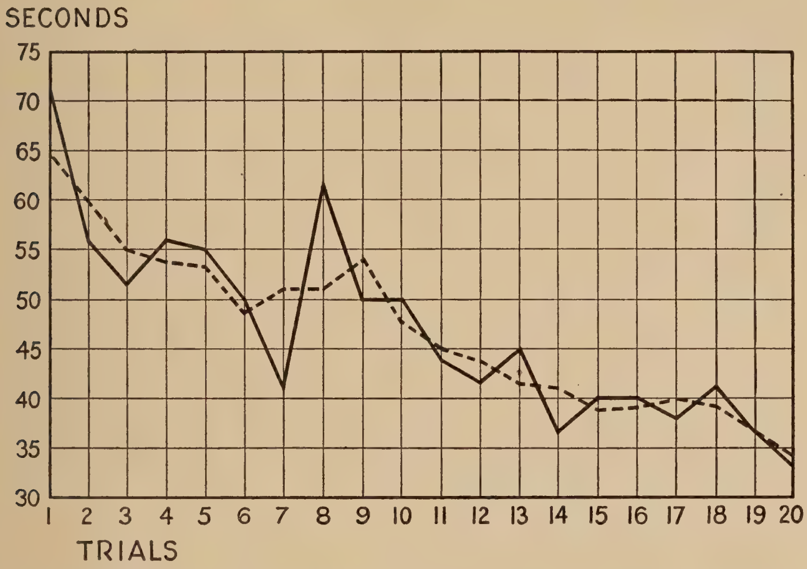

Fig. 21. Learning curve presented to illustrate fluctuations in progress. The scores represent the seconds required to sort a deck of forty cards in a prescribed manner. The solid-line curve shows the actual scores of a single subject. The dotted line shows a smoothed curve based on the same scores.

Smoothing the learning curve. Because the many fluctuations which appear in some learning curves make it difficult to see clearly the general trend of improvement, the curves are sometimes smoothed. This serves to eliminate most of the minor fluctuations and makes it easier to see how the learner has progressed in general.

There are various methods of smoothing out a curve. One way is to use for each trial, instead of the actual score, the average of the scores for that trial, the preceding trial, and the succeeding trial. In figure 21 the curve for the actual scores appears in the solid line. The smoothed curve based on the same data appears in the dotted line. The averaging method of smoothing was used in this graph. The scores for the first three trials are 72, 56, and 52. We add these three scores together and divide the sum by 3. This gives us 60, which we use as the score for the second trial in the smoothed curve. For the smooth curve score for the third trial we take the average of scores for trials 2, 3, and 4. The method is used all the way through until we reach the last trial. To find the smoothed-curve score for the first trial and the last, we double the actual score, add the one adjacent score, and divide the sum by 3.

Composite curves. The progress of a group of subjects may be indicated by a curve based on the average scores for the various trials. In figure 22 are shown the individual curves for six subjects based on their scores in a letter-digit substitution experiment. The individual curves appear in dotted and broken lines. The heavy solid line is the curve for the averages of the group. It will be observed that the composite curve is much smoother than the individual curves. This is because the fluctuations for the various trials tend to cancel out. A drop in one case is offset by a spurt made by one of the other subjects. A curve for a larger group probably would be still smoother. The composite scores

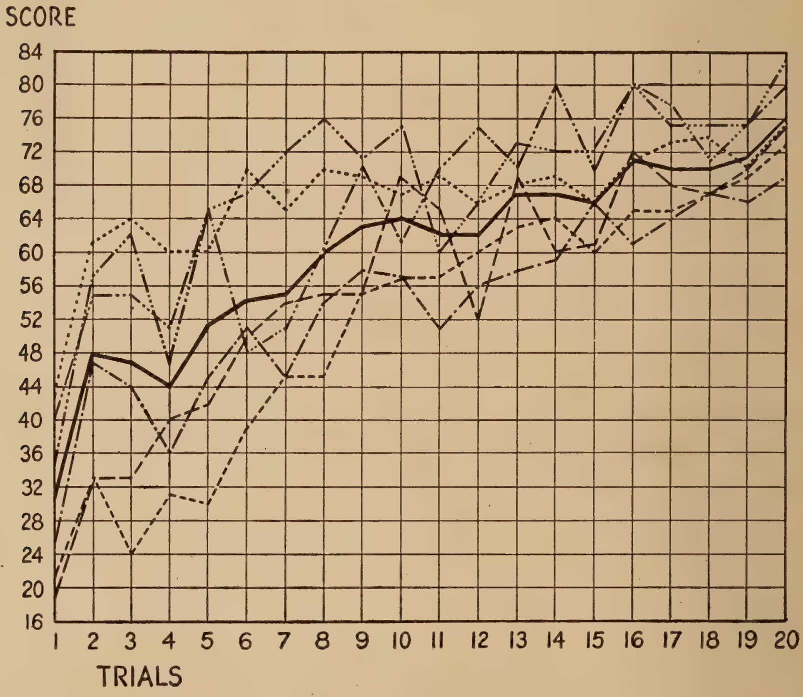

Fig. 22. Composite curve. Individual curves for six subjects in a letter-digit substitution experiment. The scores represent the number of digits written in one-minute practice periods. The dotted and broken lines are the curves for individual subjects. The heavy solid line represents the mean scores of the group for the various trials.

are useful in indicating the general course of improvement of a group taken as a whole. Any pronounced dip or sudden rise in a curve based on them reflects a potent factor common to the group rather than an individual peculiarity. A disturbance in the experimental situation which distracted the whole group, for example, might occasion a general slump.

INDIVIDUAL DIFFERENCES IN RATE OF IMPROVEMENT

The improvement or gain resulting from a given amount of practice in a performance varies for different individuals. A child of six may not be expected to gain so much proficiency in typewriting with 100 hours of practice as a high-school student. Even in a group of the same age we find that some advance faster and farther than others with an equal amount of practice. In figure 23 appear the smoothed curves for the performances of six subjects whose individual curves are shown

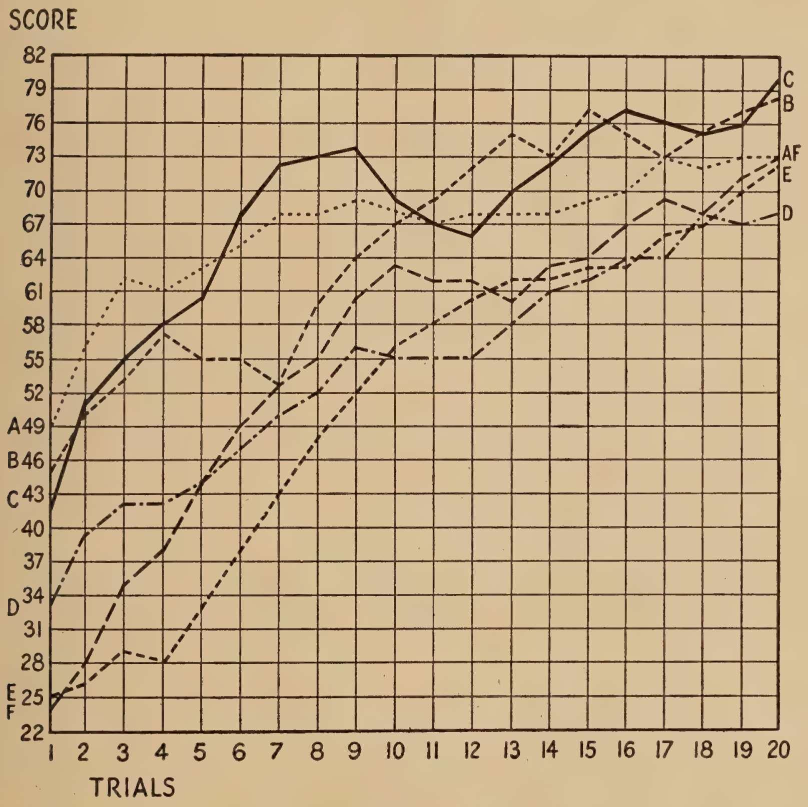

Fig. 23. Smoothed individual curves. These curves were made by smoothing the six individual curves which appear in figure 22. They show individual differences in rate of improvement and gain over the initial score.

in figure 22. These curves indicate a similar negatively accelerated trend for all six subjects, but they also show that there are differences in the rate of improvement and the amount of gain over the initial score. While A starts with the highest initial score, in the last trial he is tied with F who started with the lowest initial score. C starts third but gains more than A and B to end in first place, while D who starts in fourth place does not gain as much as E and F, so that he ends in sixth place.

The causes of such differences in improvement are difficult to determine. It may be that those who started high and failed to maintain their superiority had some factor of advantage that favored initial performance but did not contribute to gains under practice. Such an initial advantage might be provided by some special previous training or a particularly fortunate selection of a method of attack in the initial practice period.

Abilities in relation to improvement. A critical experimental investigation of this problem has been made by Woodrow (15). He sought by careful statistical analysis of the results of several tests to determine whether there was a change during continued practice in the extent to which the score of a performance depended upon the various abilities of the learner. For example, in the case of the practice on letter-digit substitution, does the performance depend on the factor of speed to a greater degree or to a less degree in the twentieth trial than in the first trial? Fifty-six subjects completed thirty-nine days of practice on each of seven tests. These tests consisted of adding, letter-digit substitution, reproducing spot-patterns, rearranging letters to make words, canceling certain letters from lines containing all the letters of the alphabet, estimating the length of various sections of a rod, and drawing four horizontal lines and one diagonal line in small printed squares. Before and after practice on these tasks, tests were given to determine the degree of various abilities possessed by the subjects. These tests included tests of intelligence, word and form analogies tests, an artificial language test, a categories test, mental multiplication, speed of making crosses, and a digit-cancellation test. The tests were aimed at discovering such factors of ability as "g" or general learning ability, attention, perception of detail, numerical aptitude, and speed. Correlations were computed for the various tests with the initial scores, final scores, and the gain scores. The gain scores were the differences between the initial and the final scores. The analysis of the correlations indicated that during practice there was a change in factor loading or the extent to which the various factors affected the score. Woodrow (15*a*) writes, In general these changes with practice in the factor loadings mean that the quantitative pattern of abilities determining goodness of performance changes with practice, i.e., a performance after practice is likely to depend for its success more on one ability or less on another than it did initially. Such a change must mean a change in the mode of operation whereby the subject carries out the task he has been instructed to accomplish.

From these tests there was no indication of an increased dependence on the "g" factor or intelligence, but there was a tendency for the loading of the speed factor to increase. The average correlation of the tests regarded as measuring intelligence with the gain scores was found to be negligible except in the case of the cancellation; and there was no indication that the gain score was related to the speed factor.

So when an individual possesses in a high degree some ability which contributes largely to the initial performance but becomes less important for the score after considerable practice, he may make a relatively high initial score but progress more slowly and gain less with a given amount of practice than another learner who rates lower in this ability but higher in one that counts more in the final score after practice. This may be the explanation of the differences between the gains of A and F whose curves appear in figure 23.

Gains in relation to initial and final scores. Woodrow (15*b*) further states that, "Gain scores usually correlate highly with final scores, whereas their correlation with initial scores seems to fluctuate, widely it is true, about zero or a small negative value." And by way of explanation he writes, "The reason why gain scores correlate higher with final than with initial scores is simply that the formula for a gain score is, *plus* final score *minus* initial score. Consequently, gain scores fluctuate directly with final scores but inversely with initial scores."

The writer has found such relations between the amount of gain and the initial and final scores in several experiments. To cite one case by way of illustration, in a letter-digit substitution experiment in which ten college students took part, the coefficient of correlation between the initial scores and the gain scores was —.48 with a P.E. of .16, while for the final scores and the gain scores, it was +.88 with a P.E. of .05. The combined scores of the four subjects who started with lowest scores were for the first trial thirty-nine points less than the combined scores of the four who made the highest records in the first trial. But in the last trial the initially low subgroup surpassed the fast beginners by twenty-four points, and their combined gains surpassed the combined gains of the fast beginners by sixty-four points.

The effect of practice on individual differences. In a study of the effect of practice on initial individual differences, Woodrow (16) sectioned each of two large practice groups into five subgroups on the basis of their initial scores. As a measure of the divergence and convergence of subgroups, he took the ratio of the standard deviation of the group means at the end of practice to the standard deviation of the initial group means. This was found by dividing the standard deviation of the final group means by the standard deviation of the initial group means. In the case of practice on horizontal adding, this ratio was 1.48 for one group and 1.89 for the other. A ratio of more than one indicated divergence. In this task, then, the subgroups which were best at the start made greater gains than the groups which were inferior at the beginning of practice. The effect of practice was to increase rather than to diminish individual differences in performance.

In the case of the majority of learning tasks employed in this study, however, the subgroups drew closer together as the result of practice. It appears from this study that the change in individual differences under practice varies with the nature of the learning task.

Since the units of raw scores may not represent equal units of ability at different parts of the scale, Woodrow converted the raw scores into scale units proportional to ability by a method of absolute scaling based on a normal distribution of ability (14). This absolute scale showed a reduction of individual differences in the subgroups in four tests, one of which was horizontal adding which showed an increase in differences on the basis of the raw scores. Thus, it appears that the apparent changes in individual differences under practice are dependent in part upon the method of scoring.

However, even with absolute scaling in two tests, substitution and spot-pattern, an increase in individual differences was found. Therefore, other factors are involved in determining the changes in individual differences in performances resulting from practice. Two suggested by Woodrow (16*a*) are differences in practice with the same or similar task prior to the experiment, and changes in the pattern of abilities determining the score. In the former case, if the learning is negatively accelerated and some subjects have had more practice before the experiment than others, they would likely have a relatively high initial score but would not improve so rapidly as those starting with a lower score. The result in such a case would be a drawing together of the individual curves toward the end of the practice period. In the second case where the pattern of abilities determining the size of the score changes as practice goes forward, individual differences in these patterns might be responsible for either an increase or a decrease in individual differences in performance.

Woodrow's factor analysis of the intercorrelations of the several tests used in his studies showed that the difference between the dependence of the final and the initial scores upon the various factors involved in the performance was greater than could be accounted for by the unreliability of the test scores. Five factors involved in the tests used were identified as: numerical, perceptual, spatial, verbal, and speed. A sixth factor, attention, was also thought to be involved in these performances (17).

It will be seen, moreover, that since the relative contribution to the score of various factors changes with practice, the findings with respect to individual differences in rate of improvement and gains will depend to an important extent upon the amount of practice which precedes the final score, or in other words, upon the degree of learning at the end of the practice period. Individual differences in rate of improvement will also be the result of varying degrees of motivation (7).

LIMITS OF IMPROVEMENT

If practice in any function is carried on long enough, the learner sooner or later reaches the limit of his ability to improve under the conditions operating at the time. Different kinds of limits are distinguished on the basis of the conditions which make further progress impossible.

Physiological limits. All activity involves physiological mechanisms and while the functioning of these mechanisms is subject to great improvement, there are limits inherent in them beyond which any amount of practice cannot produce a faster or more perfect performance. It takes a certain amount of time for the arousal of sense receptors and transmission of the nerve impulse over the fibrous pathways of the nervous system to the effectors. It takes a measurable unit of time for the muscle to contract after the impulse has reached it. Practice can reduce simple reaction times to something like one tenth of a second, but that seems to be about the minimum time required for the simple voluntary motor response. It is a limit for such a performance. Motor performances also may be limited by the capacity of the nervous system for developing coördination of movement, by the strength of the muscles, or by the amount of energy the body is able to supply. Just as no amount of practice would enable a six-weeks-old baby to walk, so no amount of practice would enable a college student to make a broad jump to fifty feet, or run a mile in one minute, simply because such levels of performance are beyond the possibilities of the normal neuromuscular equipment.

The physiological limit is probably rarely reached. To reach it requires a high degree of motivation. It is more easily reached in a simple performance such as flexing the finger as quickly as possible in response to a signal, than it is in the case of complex performances like typewriting or violin playing. In fact, so many factors are involved in the improvement of the more complex performances that it is practically impossible to know when one has reached his physiological limit. There is need for caution in assigning the cause for a final plateau to the physiological limit. This is indicated by cases of further improvement with a change to more favorable conditions when the limit of one's ability was supposed to have been reached. We cannot consider that the individual is approaching his physiological limit until he has discovered and adopted all possible short cuts, eliminated all useless movements, adopted the best possible methods, and is working at maximum motivation.

There are extensive individual differences in physiological limits. The child's limit, for many performances, is below that of the normal adult because his muscles are not so strong, he cannot execute movements so quickly, and he is inferior in ability to coördinate movements. Differences in physiological capabilities also appear among individuals of the same age.

The physiological limits may change from time to time in the same individual. Exercise may strengthen the muscles. Growth increases the possibilities of neuromuscular coördinations. Improvement in health adds to the reserves of bodily energy, and its impairment results in a lowering of physical stamina. In general, the limits of improvement rise from infancy to maturity, fluctuate with changes in health and bodily vigor, and drop to lower levels of achievement in old age.

When one approaches his physiological limit in a complex performance, further increments of improvement require more and more effort. The returns for time and effort expended diminish. In the case of typewriting, for example, an increase in speed beyond sixty words per minute requires a great amount of diligent practice. For these reasons, and because of other limits to be considered, most persons seldom reach their physiological limits of improvement, and in most cases it would be a waste of effort and time to do so.

Practical limits. The absolute limit of efficiency in any function and the degree of excellence which is good enough for all practical purposes are usually quite different. The degree of proficiency sufficient to meet all normal demands is called the *practical limit.* It is frequently very much lower than the absolute limit of improvement. Workers in industrial establishments, clerks, stenographers, and others tend to strike a level of proficiency good enough to get them by, and then go on year after year without making any improvement in their work. That this level is much below their possible achievement is shown by the fact that under the incentive of demands for a better grade of work as the price for retaining their position, or under the stimulus of competition with other workers for a coveted promotion, they apply themselves with greater diligence and thereby increase their efficiency.

Students in college courses probably never do their absolute best. They are usually satisfied with a good grade, and sometimes with a mediocre grade that gives them credits toward a degree. More time and more effort would enable them to accomplish a greater degree of mastery of any subject, but they have to divide their time between several subjects and other activities.

The child might be able to learn to spell all the words in the dictionary, but the cost of such an achievement would be entirely incompatible with its practical value. It is considered a waste of a child's time to require him to learn the spelling of more than two thousand of the most commonly used words. The practice of requiring children to learn scores of historical dates which will rarely be encountered in reading, or of requiring the mastery of problems involving eight- or ten-place decimals is now vigorously challenged by educators. The practical limit of proficiency in the use of decimals is certainly far below the maximum possible attainment. The practical limits of training in any school subject must be determined by a consideration of individual and social needs in relation to the values the subject offers. Subject matter that does not minister to the needs of the child, and that which will be of no use to him, should not be forced upon him. To require a child to learn useless material is to waste his time and deprive him of more essential training (13).

Method limits. A learner may reach a level of proficiency that is the very best he can do with the method he is using. He is then said to have reached his *method limit.* He cannot then improve until he in some way strikes upon a more effective method of performing his task. In discussing plateaus it was pointed out that studies have shown that a rise of the curve after a plateau coincided with the adoption of higher units of performance, such as typing groups of letters in a unit instead of one letter at a time. A child may not be able to improve his handwriting because of a faulty method of holding his pen. One's improvement in speed of adding reaches a limit very easily if he continues to employ a counting method. In typing, the speed limit for the "eye-and-finger" method is usually considerably below that of the "touch" system.

The essential thing in order to go beyond the method limit is for the learner to discover and put into practice a new and better method of procedure. While in some cases the learner may hit upon a better method through insight, reflection, or by trying out various methods, it will be necessary in many cases for the teacher to point out more effective methods of work. The teacher should be alert to detect faulty methods, which preclude progress, and help the child to overcome them. He should watch the child's progress to discover the opportune time for the adoption of higher units of operation. In addition, for example, when the pupil has mastered the process of adding single numbers, the teacher should point out the possibilities of grouping two or more consecutive numbers, such as seeing *7* and *3*, or *6* and *4*, as *10*. Later he may be able to group three numbers together into a single response. As he does this he will increase his speed beyond the limit for the one-number units. Word-by-word readers will not be able to read so rapidly as those who read by phrases. Likewise the achievement of a high-school student may be restricted by poor habits of study.

Motivation limits. A person has reached his *motivation limit* of improvement when he is content with his present achievement and is not interested in doing better. Much poor work in school is due, not to lack of ability, but to lack of application of effort because of insufficient motivation.

Incentives determine in a large measure how far a person advances his skill and knowledge. A comparatively few persons in every field of endeavor rise above the level of mediocrity. A few train dispatchers emerge from the mass of telegraphers. Occasionally a great captain of industry rises from the ranks of common machinists. One boy out of thousands growing up on the sidewalks of a great city reaches fame as a leader in national politics. To become great requires energy, ability, and opportunity, but these essentials, without the *will to succeed,* will not produce greatness. There is probably no case more difficult for a student counselor to handle than that of the young man of high-grade ability who does not care whether he makes anything of himself or not. The lack of desire to improve, lack of interest in achievement, and satisfaction with mediocrity prevent a person from reaching the possibilities of which he is capable. There are probably few cases where a person's performance cannot be improved if a sufficiently strong motive is established.

The teacher's task is to stimulate learning activity as well as to direct it. He should try to inspire each child to do his best. Many children need to be told that they can do better. But in attempting to get a child to seek attainments worthy of his abilities, the teacher must, of course, be careful not to overestimate the ability of the child. Serious emotional damage may be done to a child if parents or teachers arouse within him ambitions that surpass his ability. We should not doom a child to frustration and the bitterness of defeat by overdoing motivation.

The Teacher's Use of Learning Curves

As we have seen, learning curves provide a graphic record of the course of learning. They reveal the fluctuations in progress, stages of rapid advancement, periods of slowing down, and the plateaus where no apparent improvement is being made even when practice is continued. The teacher may use them for her own enlightenment and as an impressive means for informing pupils of their progress. Learning graphs based on scores derived from standardized tests may indicate whether satisfactory advancement is or is not being made by the pupils individually or as a class. Plateaus in those curves will serve as a warning that all is not going well. They may indicate the intrusion of some detrimental factor, the need for a change in teaching methods, or the desirability of some new form of incentive.

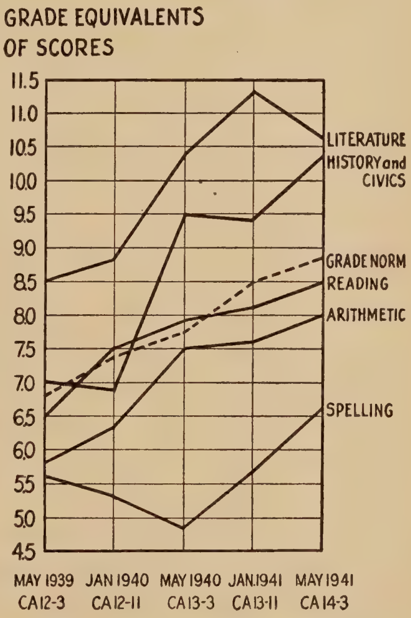

Fig. 24. A two-year record of the progress in five school subjects made by a pupil of average intelligence.

In figure 24 are presented curves showing the progress in five school subjects of a pupil of average intelligence over a period of two years. They are based on grade equivalents of scores which the pupil made on the Metropolitan Achievement Tests given at the midyear period near the end of January and at the close of the school year near the end of May. This sample record was selected at random from the school's test files.

The standing of the pupil in the five subjects is indicated by solid-line curves. The dotted line shows the grade norm for the pupil's attained age. An examination of this graph reveals many things concerning this pupil's accomplishments. First, we see a marked difference between his achievement in the five subjects as indicated by his performance on these standardized tests. His literature curve is consistently much higher than the grade norm. The curve for history and civics begins near the grade norm but rises considerably above it during the two years. Reading keeps pretty close to the grade norm throughout, but falls off slightly in the second year. Arithmetic is down, but is slightly nearer the norm at the end of the two years than at the start. Before seeing this graph the child's teacher had not realized that he was so much below his grade norm in arithmetic. The curve for spelling shows a marked deficiency in that subject. It reveals that while this child was 1.2 grades below where he should have been in spelling at the beginning of this period, after the two years he was 2.2 grades below the standard for his age. During these two years he made but one year's advance in this subject. The graph reveals the areas in which the child has and has not been making satisfactory progress. It indicates the need for discovering and correcting the causes of his deficiencies in arithmetic and spelling.

As a means of informing pupils concerning their progress, learning curves, if wisely used, may serve as a valuable motivation device. Everyone desires to know what his efforts are accomplishing, and the graphic method of portraying progress is especially effective in the case of children. Learning graphs may be built on the scores from the teacher's own weekly or monthly tests. As each new score is made, the curve is extended, showing how much advance has been made over previous scores. Many teachers have found that children become greatly interested in their curves and try hard to make them go up. An upward swing of the curve brings great satisfaction, while its failure to rise is often effective as a stimulus to greater effort.

Although in curves used for the sole purpose of motivation some lapse from scientific precision may be condoned, it should be remembered that a suitable curve requires that the successive tasks from which the scores are derived should be of approximately equal difficulty and scorable in terms of units of approximately equal value. It is also essential that the tests be given at regular intervals and that they measure the same kind of ability. For example, a curve might easily be constructed to show monthly gains in speed in typewriting by means of scores representing the number of letters written per minute. Gains in accuracy could be plotted by using for scores the number of errors made in typing a given number of words. Improvement in rate of reading could be graphed from time scores derived from weekly tests on passages of uniform length and difficulty. Weekly gains in the learning of the addition facts could be represented graphically by using for scores the total number of such facts mastered after each week's study.

Summary of the Chapter

The purpose of teaching is to secure improvement. The learning curve is a convenient device for depicting graphically the course and amount of improvement made during practice. When scores increase as the performance grows better, improvement is indicated by an upward curve. If the scores decrease as performance improves, advancement is shown by a downward curve. A positively accelerated curve is one showing an increasing rate of improvement. When the rate of improvement decreases, the curve is negatively accelerated. Most curves of motor learning show negative acceleration.

Plateaus are level places in a learning curve. They indicate periods of no apparent progress. They may be due to loss of interest, or to inadequate method. Most curves of learning show irregularities in progress.

There are significant individual differences in the rate of improvement. This is believed to be due to differences in ability, previous practice, and motivation, and to changes in the relative dependence of the score on various abilities possessed by the learners. It is frequently found that individuals who make relatively low initial scores gain more than those who make the higher scores at the start. In some learning tasks, initial differences are increased with practice, while in other cases they are lessened.

Four kinds of limits of improvement were considered. The *physiological limit* is the level of proficiency beyond which one cannot improve because of restrictions inherent in the nature and capacity of the physiological mechanisms involved. *Practical limits* are levels of proficiency beyond which there is no practical value in securing additional improvement. *Method limits* are reached when one is doing the best that is possible with the particular method which he is using. *Motivation limits* are reached when one does not have any interest or desire for further improvement. The absolute limit of improvement is rarely reached.

Learning curves based on test scores made by pupils may be helpful to teachers by showing how individual children or classes are advancing in various school subjects. They may also serve as incentives to stimulate children to work for gains.

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CHAPTER X

PHYSICAL HANDICAPS TO LEARNING

FATIGUE

Continuous work produces fatigue, which is manifest in a decline in the quality and quantity of output. In learning, fatigue tends to counteract the effects of practice and to decrease the efficiency of study. When fatigue sets in, performance slows down, errors increase, and the ability to sustain attention diminishes. This means in the case of long continued practice a leveling off and an eventual decline of the learning curve. Thus, the value of practice decreases as fatigue increases. In some cases performance is better after an interval of no practice than at the end of the practice period. A plausible explanation seems to be that the gain due to recovery from fatigue more than counterbalances the loss from lack of practice during the interval. It has been shown, also, that fatigue at the time of studying has an adverse effect on retention as well as on the efficiency of learning itself. Morgan (30), for example, found that material mastered during the first part of a long learning period was remembered better than the material learned near the end of the period.

Any activity consumes energy. This energy is provided by the cells of the muscles and nervous system. As the energy-holding compounds of the cells are used, waste products are formed. These products are toxic substances, the most important of which are carbon dioxide and lactic acid. They are normally carried off by the blood stream, but when they accumulate faster than they can be removed, the various symptoms of fatigue appear.

Mental and physical fatigue. It is customary to distinguish two forms of fatigue: first, physical; and second, psychological or mental. The former results from continuous exercise of the muscles and the consequent depletion of energy and accumulation of waste products. It is marked by a lessening of the ability to work and by a decline in the quality of the performance. It is a case of actually being tired *by* one's work. Mental fatigue, on the other hand, is a matter of being tired *of* one's work. It is marked by a decline of interest, zest, attention, and the satisfyingness of one's labors; by an increase in errors, boredom and feelings of weariness; and by a disinclination to continue. Recovery from physical fatigue calls for a rest, while recovery from mental fatigue is often brought about by a change of posture, occupation, incentive, or outlook. The feelings of weariness characteristic of mental fatigue are not reliable indicators of the extent to which one has actually used up his reserves of energy.

Fatigue symptoms. Temporary fatigue, either psychological or physical, while detrimental to good work, is normal and is usually removed by rest, sleep, and recreation. However, if one continues day after day to use up more energy than he builds, fatigue becomes a chronic liability to good work and health. Some symptoms of an advanced state of fatigue are: loss of weight and appetite, faster and shallower breathing, feelings of depression, tendency to worry, inability to recall well-known facts or names, inability to express thoughts in appropriate words, irritability, poor control of emotions, and other indications of reduced self-control.

Factors conducive to fatigue. There are a number of factors other than work itself that influence the onset of fatigue, both physical and psychological. Among those conducive to fatigue are: poor lighting, poor tools or equipment, a desk that is too high or too low for comfort, slouched or cramped position during work, anxiety produced by a pace that is too fast, monotony, distractions, dislike for the job, and emotional conflicts. Young children are likely to be more easily fatigued by continuous work than older ones, and in the early stages of learning practice is usually more fatiguing than in the later stages, for habituation lessens fatigue effects.

Fatigue of school children. Tests made repeatedly on various activities throughout the day have shown fairly consistent variations in the efficiency of work for different periods. The results of research agree in showing a rise in the curve of efficiency from the first period in the morning to a point of maximum efficiency near noon or about three hours after the beginning of work. Then there is usually a slump during the noon hour to about one o'clock with the curve sometimes but not always dropping to a point near or slightly below the early morning level. This is followed by a rise to about three o'clock and a decline from that point to five o'clock. Gates (17), for example, tested fifth- and sixth-grade pupils repeatedly at various periods from 9 A.M. to 3 P.M. He concluded that for the "more strictly mental functions" (addition, multiplication, memory, and recognition) the period of lowest efficiency was the first one of the morning and that highest efficiency was reached between 11 and 12 o'clock. For tests of speed and accuracy of movement there was continued improvement throughout the day with the best performance coming in the middle of the afternoon. Similar results were obtained by this investigator with college students who were tested at the various hours from eight o'clock in the morning until five in the afternoon. Results from a study by Stainer (36) in which five-minute tests in addition were given at forty-five-minute intervals indicated a tendency for pupils to reach maximum efficiency about three hours after the opening of school in the morning. After that there was a slight decline, some recovery, and decline again later in the afternoon.

Extensive experiments were conducted in several city school systems under the direction of Pyle (33) to determine whether children's ability to learn is less in the late afternoon than in the morning hours. He concluded that the ability to learn just before the time of closing in the afternoon was only about two per cent less than in the forenoon. Earlier studies by Heck (21) and others on this problem have indicated that ordinary schoolwork produces very little actual fatigue. The slump that so often comes in the afternoon is not due to inability to work, but rather to feelings of weariness, loss of interest, boredom, and the desire to get out for a change to more agreeable forms of activity (27). If the pupil is sufficiently motivated and if tasks are varied, effective work should be sustained until the end of the school day.

Recovery. The recovery from fatigue occasioned by mental work is said to take place at a negatively accelerated rate. It appears to progress most rapidly during the first few minutes of rest (4). The essential means for recovering from fatigue are: rest, relaxation, recreation, and sleep. Recreation gives expression to the fundamental motives. Outdoor play and social activities provide new satisfactions and reduce the tensions and strains occasioned by one's work. Rest and sleep enable the body to rebuild the diminished reserves of energy.

Much has been written about the amount of sleep necessary for keeping one at maximum working efficiency. Estimates vary considerably, and it appears that the amount of sleep needed differs for different persons. It is generally agreed that children normally require more sleep than adults, and young children require more than older ones. The following estimates for the various ages are based on the opinions of several writers:

Ages	5-6	7-11	12-14	16-20
Estimated hours of sleep needed	12-11	11-10	10-9	9-8

Several studies have indicated, however, that the actual amount of sleep which children get usually falls considerably below this standard. Terman and Almack suggest that the wisest course is probably to let each child sleep as many hours per day as he does naturally (37*a*).

Distractions. The effect of distractions, as shown by a number of studies, is to lower efficiency and to make work more difficult (8). It requires greater effort to learn under distracting conditions than in a room free from them (28). Distractions tend to increase muscular tensions and to hasten fatigue. Material learned under noisy conditions is not retained so well as that learned under more favorable conditions (29). For efficient learning, therefore, unnecessary noises and other factors which distract the learner should be avoided. Children are, as a rule, more easily distracted than adults. It is possible for a learner to achieve a certain amount of adaptation to noises which at first disturb concentration, and it is easier to adapt to regularly repeated or continuous ones than to those which are sudden and unusual. Adaptation should be sought in the case of noises which cannot be avoided and which are normal to the learner's environment.

POOR VENTILATION

One cannot do his best work in a poorly ventilated room. The lowering of efficiency occasioned by the lack of adequate ventilation is not usually due, as is often supposed, to the reduction of the amount of oxygen in the air or to the increase of carbon dioxide. Insufficient oxygen would of course be serious, but in the ordinary ill-ventilated room the reduction of the oxygen content of the air is actually slight and far from the critical point for mental work. If the carbon dioxide content of the air were increased from the normal amount, which is about 0.04 per cent, to about six per cent the effect would be harmful; but under conditions of ordinary poor ventilation it is increased only to about 0.3 per cent, and it is said never to go beyond 0.4 per cent in the most poorly ventilated schoolroom (37*b*). The deleterious effects of inadequate ventilation are found rather in the discomfort caused by high temperature, high humidity, and lack of circulation of the air.

Several good studies have been made on this problem by means of airtight compartments that made possible the exact control of the various factors mentioned. So long as the air was kept cool, or kept circulating by means of an electric fan, the persons in one of these cabinets suffered no ill effects when the amount of CO_2 was several times higher and the oxygen content far lower than that of the air which one ordinarily encounters in a badly ventilated room. With a temperature of seventy-two degrees in such a cabinet, however, after a very few minutes such symptoms as faintness, dizziness, headaches, and mental dullness appeared. Moreover, subjects who stood outside the cabinet and breathed the "bad" air from within it through tubes did not feel any ill effects, while subjects in the hot and stagnant air inside the cabinet did not secure any relief from their discomfort by breathing pure air from the outside through tubes.

Other studies have shown the value of circulation of air for comfort and mental efficiency. In one it was demonstrated that school children can do as well when the old air is recirculated as when new air is introduced from the outside (39). Moving air has a cooling and beneficial effect because it makes possible the more rapid evaporation of moisture from the surface of the body. It is generally considered that a temperature of from sixty-five to seventy degrees Fahrenheit and a relative humidity of about fifty per cent are most favorable for efficient work. Higher temperatures and moist, sultry air produce physical discomforts which greatly reduce the inclination to work and increase the effort required to perform a task (22, 31, 38).

Physical Defects

Although it is generally assumed that physical defects tend to retard school progress, definite evidence in substantiation of this view is difficult to find. It appears that some defects do not interfere with school progress while others seem to be serious handicaps. Apparently the retarding influence of defects depends upon several factors, such as their nature, number, and severity, and the attitude the pupil takes toward them. In many cases the effect on schoolwork is indirect, as when a defect produces a sense of inferiority or leads to habits of dependence upon others or to the practice of using it as a means of escape from responsibility.

One of the best objective studies of the relation of physical defects to school achievement was made by Mallory (26). His findings, based on standard achievement tests and physical examinations, led to the conclusion that physical defects contribute to retardation, but that some defects are greater handicaps to progress than others. The defects, presented in the order of the degree to which they were found to be related negatively to achievement, were: nasal obstructions, defective teeth, poor hearing, defective tonsils, and impaired vision.

The estimates of the prevalence of defects made by investigators vary widely due, probably, to different methods of examination and to differences in views regarding what types and degrees of deviation from perfection are to be considered defects. Several studies have indicated that between fifty and seventy-five per cent of the children in our schools are the victims of some kind of physical defect. The need for thorough physical examinations and remedial measures is evident.

Defects of vision. The eyes are used so constantly in school learning that any serious impairment of vision is certain to prove a handicap to the pupil. This handicap cannot be adequately measured in terms of actual retardation because many pupils may compensate for it by extra effort but in so doing suffer added strain, discomfort, and fatigue. Visual defects appear in many forms and in varying degrees. Estimates of their prevalence in the school population vary from around ten or twelve per cent to about twenty-five per cent (37*c*), depending no doubt upon what degree of deviation from perfect vision the examiner considers a defect and upon the thoroughness of the examining procedures.

Errors of refraction. Among the more common forms of visual defect are the errors of refraction, known as *myopia, hypermetropia,* and *astigmatism*. They are characterized by faulty focusing of the light upon the retina. Adequate focusing is essential to clear vision.

In myopia, or nearsightedness, the rays of light entering the eye focus before they reach the retina, due to excessive convergence produced by the lens or to the fact that the antero-posterior diameter of the eye is too long. Near vision is less likely than far vision to be impaired by a myopic condition, since the rays of light from near objects diverge in proportion to their nearness to the eye, and if near enough this divergence will sometimes compensate for the excessive convergence which takes place within the eye. Thus, the myopic pupil may be able to see fairly well by holding his book or other objects very close to his eyes. He is likely, however, to be unable to see things on the blackboard. Myopia is rarely found in young children, but it appears more frequently in the middle and upper grades. This fact has led some to believe that the use of the eyes in the school for so much close work tends to produce this defect. Since the concave type of lens causes light rays to diverge, it is used in glasses to correct visual deficiency due to myopia.

Hypermetropia, or farsightedness, is a condition in which the distance from the lens to the retina is too short for a clear retinal image, or in which the refractive power of the lens is insufficient. The convergence is not sufficient to focus the rays of light on the retina, and so the focal point falls behind it. This means blurred vision. Eames (13) states that a hypermetropic child can sometimes achieve clear vision at the expense of excessive strain on the muscles of accommodation. To see clearly he must first compensate for his refractive error by a certain amount of accommodation, and then he must secure the accommodation required to focus the normal eye. Since near vision requires a greater degree of accommodation than distant vision, the latter will require less accommodative compensation of the hypermetropic eye for clear vision. Some hypermetropic cases are able to compensate for both near and distant vision. They may show no improvement in visual acuity when fitted with glasses. The purpose of the glasses in these cases is to relieve the child of the strain caused by the compensating accommodation. Other cases are able to compensate for distant vision but for them the accommodation load for near vision is too great. For these cases distant vision is good, while near vision is defective. Given suitable glasses they will show improvement for near vision but not for distant vision. Some hypermetropic children are unable to compensate sufficiently to secure clear vision for either near or far objects. They show improved visual acuity with glasses for both distances (13). Since the convex form of lens produces convergence of the light rays, they are used in the correction of this error of refraction. Hypermetropia is quite common among young children and appears less frequently in the upper grades and high school (6).

In astigmatism the curvature of the lens or cornea of the eye is irregular and this causes uneven focusing of the light on the retina. The child who has astigmatism sees more clearly in one meridian of his visual field than in others. Astigmatism may be either myopic or hypermetropic. The latter is by far the more common among school children. For correction a lens must be prepared in such a shape as to compensate for the irregularities of the refracting media of the eye.

Muscular deviations. For clear vision there must be sufficient coördination of the eyes to bring about convergence of the lines of vision on the object to be seen. This convergence is controlled by muscles external to the eyeballs. *Heterophoria* is a condition in which the muscles are unable to secure adequate convergence. It appears in various forms. In exophoria the eyes do not converge sufficiently. In esophoria they turn in too much. Sometimes one eye turns upward more than the other. In a study of 350 poor readers Eames (12) found incoördination difficulties at the reading distance in about one half the cases. This defect was marked in more than a fourth of all the cases. For distant vision deficient coördination was found in about one tenth of the poor readers. Many persons suffer from slight incoördination of the eyes without noticeable effects, though there may be impairment of their binocular vision and strain occasioned by the effort to secure clear vision. In serious cases there may be inability to fuse the images from the two eyes into single vision. This may lead to the suppression of one and the eventual loss of sight from one of the eyes.

Aniseikonia. The condition known as *aniseikonia* is one in which the "ocular images" are unequal in shape, in size, or in both shape and size. It is believed by those who have studied this defect extensively that many persons who have such symptoms as headaches, dizziness, or nervousness associated with the use of their eyes and who do not exhibit the ordinary ocular defects may have aniseikonia. This, like other visual defects, appears in varying degrees, and patients differ in the extent to which they can tolerate or compensate for it. For several years this defect has been investigated at the Dartmouth Eye Institute. It has been found to have a significant relation to reading disability (9) and anomalies of visual space perception. It is measured by means of an eikonometer, and its correction is accomplished by means of special aniseikonic lenses which have a specified refractive power and magnification (1, 2, 3, 7, 18).

Visual defects and schoolwork. Many studies have indicated the relation of defective eyesight to poor reading. In the study of 350 poor readers by Eames (12), mentioned above, about one third had defective vision when both eyes were used. About two thirds of the right eyes, and three fourths of the left eyes exhibited defective vision. Refractive errors of 0.62 diopter and higher appeared in 58.6 per cent; of 1.00 diopter or higher, in 35.2 per cent. Heterophoria of four or more prism diopters appeared for near vision in 49.7 per cent; of six or more prism diopters, in 28.2 per cent. Several cases showed constrictions of the visual field. This writer states that incoördination of the eyes is the defect most frequently encountered among poor readers and that this factor appears much more frequently among pupils with reading difficulties than among unselected controls. The predominant type of incoördination, according to this authority, is exophoria. He writes (11*a*), "It results in the early onset of fatigue, insufficiency of convergence in reading, impaired fusion, irritability, and inattention." Other conditions which Dr. Eames finds related to poor reading ability are: farsightedness, anomalies of eyedness, and low fusions of the images from the two eyes. He finds very few astigmatic reading cases, and nearsightedness is reported as an "infrequent offender" with respect to reading. He suggests that a low degree of myopia may even favor reading, as the child will need to exert less than the usual amount of effort to secure adequate accommodation for near vision (11).

These findings are in substantial agreement with those of Farris (16), who found that hypermetropia and muscular deviations were associated with poor reading progress but that myopia and myopic astigmatism were associated with better than average progress. Correction lenses aided achievement in the cases of those defects associated with poor reading. Imus (25) reports from a study of 100 first-grade children by the Dartmouth Eye Institute that approximately twenty-five per cent had defective vision to a degree that warranted corrective measures and that some of these cases were probably handicapped in reading by their defects. Schwartz (34) reports improvement in seventy-one per cent of the cases of poor readers after correction was made for ocular defects. In a study of fifty unselected cases of reading failure Eames (14) found that eighty per cent had visual trouble of some kind. These were given glasses or treatment. Half of them, those with I.Q.'s below ninety, did not gain any more in reading during the year following treatment than they did the year before. But the forty per cent who had eye trouble and whose I.Q.'s were above ninety gained thirteen months in reading age during the ten months following correction or treatment as against a gain of seven months for the year before treatment. Twenty per cent of the total group of reading failures had no eye trouble. It is recognized that poor reading may be due to several conditions other than defective vision; but that such defects often are the primary cause of reading disability seems clear (10, 20), and the need for professional examination and ocular therapeutics is definitely indicated.

Teachers should understand that glasses do not always free a child from visual handicaps. Of such cases Eames (15) writes:

> When a child has low vision which is only partially improved by glasses or which cannot be improved at all, the teacher should not expect the pupil to compete with normally seeing children. He should be given a seat in a good light, be given frequent rest periods, be permitted to look out of the window whenever he wants to (because looking out of the window rests the focusing muscles), and be provided with textbooks having large, boldface type. He should be allowed to use a heavy, soft pencil and to write script large enough for him to see clearly. If vision is markedly low, placement in a sight-saving class should be considered.

Defective hearing. Deviations from the normal in hearing appear in all degrees from that which is scarcely noticeable to total deafness. The percentages of children found in various studies to be afflicted with auditory deficiency vary widely. This variation is due in part, no doubt, to differences in the standards of the examiners. On the basis of the reports of many studies Terman and Almack conclude that from ten to twenty per cent of school children have subnormal hearing and that for two or three per cent the deficiency is serious (37*d*).

Diseased conditions of the nasal passages and the throat, which tend to block the Eustachian tube, are credited with being the most prolific sources of impaired hearing. These include diseased and enlarged tonsils and adenoids, and chronic catarrh. Scarlet fever and measles are also common sources because they frequently cause inflammation of the middle ear. Aching or discharging ears are indications of trouble and should receive prompt attention. Teachers are likely to overlook cases of poor hearing, and to regard the child as stupid or annoyingly inattentive.

Adequate hearing tests should be given to all children in order to discover those whose hearing is deficient. When cases of defective hearing are found, the necessary treatment should be secured not only for the sake of better schoolwork but also to prevent the development of serious deafness. This will be the responsibility of the school physician, specialists, and parents. In the meantime, the teacher can let the child who is hard of hearing sit near the front of the room and show him the special consideration that his handicap warrants.

That poor hearing is a handicap to achievement under ordinary classroom procedures can scarcely be doubted, particularly if the deficiency is severe enough to cause a child to fail to hear much that is said. A survey of the elementary school pupils of New York City indicated that 3.17 per cent of all the children had impaired hearing in both ears, and approximately forty-two per cent of the hard-of-hearing children were retarded one year or more (5). The number of cases of retardation was greatly reduced by instruction in lip reading.

Retardation statistics, however, cannot show us the full significance of poor hearing for the child in school. Some children may compensate for their deficiency by extra effort at the expense of strain, anxiety, and fatigue. The partially deaf child is likely to be sensitive about his defect. He may feel that he is different from other children and suffer from a sense of inferiority, or develop other unwholesome emotional reactions. Evidence to this effect was revealed by a study of a group of deaf children in the New York City public schools (35). The Brown Personality Inventory for Children was given to 397 deaf children and to a hearing control group of 327 children. The deaf children received much higher neurotic scores than the hearing controls. According to the norms of the test they made a "very poor adjustment." The older deaf children, both boys and girls, tended slightly to make higher neurotic scores than the younger. The age at the onset of deafness appeared to influence the neurotic scores of the girls; those who were older at the time they became deaf tended to make higher scores. This tendency was not observed in the case of the boys. It seems reasonable to suppose that what is shown here for the deaf might also be true to some degree for the partially deaf.

DRUGS

There has been considerable interest among psychologists in the effect of drugs on efficiency of work. Many books on educational psychology discuss this subject, but since it has little to do with classroom learning we shall not attempt here to review the work done on the problem. Perhaps the influence of tobacco is important because of the prevalence of smoking among high-school and college students. But studies on the effect of smoking have not always agreed and there seems as yet to be no satisfactory evidence for or against its use. A number of studies have shown nonsmoking students to make higher grades than smokers, but they have not clearly demonstrated that this difference is not due to other factors, such as social habits and personality traits. Alcohol tends to reduce the scores on mental and motor tests, and its use is generally regarded as unfavorable to efficient work (24). Several experiments have been made on the effect of caffeine, the drug found in coffee and tea. In one study subjects exhibited an increase in speed of movement after taking caffeine and the effect varied with the size of the dose. Small doses aided coördination of movement while large doses were detrimental to this aspect of performance (23, 32).

SUMMARY OF THE CHAPTER

Fatigue results from continuous work. It is manifest in a decline in feeling-tone and in the output of work. Fatigue counteracts and diminishes the effect of practice. Physical fatigue is inability to work caused by the reduction of bodily energy. Mental fatigue is a disinclination to work caused by boredom and characterized by feelings of weariness. Symptoms of fatigue besides decline of work are tendency to worry, a slowing up of the associative processes, and poor emotional control. Poor lighting, poor equipment, bad posture, monotony, distractions, and worry are conducive to fatigue. The work of the ordinary school day does not produce much real fatigue in children. For recovery from fatigue one needs rest, relaxation, recreation, and sleep.

The deleterious effects of inadequate ventilation are due primarily to high temperatures and high humidity. Physical defects are often, though not always, handicaps to learning. Troublesome defects of vision are: first, errors of refraction—myopia, hypermetropia, and astigmatism; second, muscular deviations which result in incoördination of the eyes; and third, aniseikonia. Hypermetropia is common among young children but tends to decrease with age. Myopia is rare in the young but increases in frequency with increase in age of children. Defective hearing appears in about five per cent of the school population to such a degree that it is a handicap to learning. Some drugs in mild doses may stimulate learning temporarily, but large doses are deleterious, and their continued use may be harmful.

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PART IV

SEVEN FORMS OF LEARNING

1. DEVELOPMENT OF MOTOR SKILLS
2. DEVELOPMENT OF PERCEPTION
3. MEMORIZING
4. DEVELOPMENT OF UNDERSTANDING
5. DEVELOPMENT OF PROBLEM-SOLVING THINKING
6. DEVELOPMENT OF EMOTIONAL ACTIVITIES
7. DEVELOPMENT OF ATTITUDES AND IDEALS

CHAPTER XI

THE DEVELOPMENT OF MOTOR SKILLS

An individual's ability to meet the demands made upon him by his environment depends upon the acquisition of a great many motor skills, the skills that involve bodily movement. To possess such skills means to be able to act with dexterity and proficiency. Every normal individual acquires a large number of motor skills, some quite incidentally as various acts are performed again and again, others by dint of much effort and time spent in practice to achieve high levels of expertness for their monetary or social values. Since the action skills play so significant a role in the lives of every one of us and because the school undertakes to teach a number of them, their acquisition deserves careful study. This chapter is devoted to those cases of learning through which action is modified in the direction of skilled performance.

In the chapters which follow we shall be concerned with six other forms of learning with which the school is directly concerned, namely, the development of perception, memorization, the acquiring of understanding, problem-solving thinking, the modification of emotional reactions, and the development of attitudes and ideals. Learning appears in many different forms, and it is not presumed that these seven forms of learning present a hard and fast logical classification. This grouping is based primarily upon the outcomes of learning. The functions operating to bring about learning may or may not be of the same type as those altered as a result of the learning. Action involved in practicing a motor skill leads to changes in the action; but comprehension may modify perception, and thinking out the solution of a problem may improve comprehension. The activities that serve to alter or develop an attitude may be altogether different from those governed by the attitude.

In general this classification of types of learning, based on outcomes, corresponds to the major forms of learning fostered by the school. However, in the more complex cases of learning two or more of our seven types may be involved. For example, in learning to typewrite we have some memorizing, although this learning is predominantly motor. Reading is a complex process psychologically, and in learning to read we have the coalescence of several forms of learning. A certain amount of motor control must be acquired in order to insure appropriate eye movements; perception is refined in order that the reader may quickly apprehend small but significant differences in letter patterns; associations are formed; and comprehension is developed.

Examples of Motor Skills

Motor skills in everyday life. There are a great many forms of action skills used in everyday life. Their possession is an asset in many ways. They mean greater efficiency in one's work; they enhance self-esteem; they bring social recognition, and are the source of rich satisfactions and pleasures. Among the activities associated with making a livelihood and involving motor skills are operating machines of various sorts, painting, carpentering, drafting, weaving, surgery, plumbing, masonry, and dramatic performances on the stage. For recreation and enjoyment, we have such skills as swimming, baseball, tennis, ping-pong, skiing, rowing, dancing, singing, and playing musical instruments.

Not only does one find satisfaction in being able to do things with dexterity, but most persons enjoy watching feats of skill performed by others. The clever handling of a huge steamshovel soon draws a crowd of interested spectators. The juggler and the acrobat have a secure place in the entertainment world. A cleverly executed football play is admired even when it is made by the opposing team.

Motor skills taught in schools. In school every child is expected to learn to write. So important as a tool for further learning is the ability to write that he is started on this skill in the first grade and his training is continued through the elementary grades. In high school we have typewriting and the manual arts. Other school activities in which the motor functions are paramount are sewing, drawing, singing, pronunciation of words, athletic games, and gymnasium exercises. Training in mechanical arts, drafting, shopwork, and the trades is a matter of developing motor skills. In the kindergarten are found such motor activities as singing, bouncing balls, sewing designs on cards with yarn, marching, cutting paper with scissors, and coloring pictures with crayons. Skill in reading requires among other things the ability to make finely coördinated eye movements in order to keep on the line, to move forward in rapid sweeps, and to shift back and catch the beginning of the next line quickly.

Laboratory forms of sensorimotor learning. The development of proficiency in motor functions has been extensively studied by means of laboratory experiments. In these experiments there has been an attempt to secure relatively simple types of performance which are new to the subject. The simplicity of the activity chosen makes it easier to control the factors involved and to analyze the fundamental features of the process. The novelty of the tasks largely precludes the variables resulting from prior experiences and practice and enables the experimenter to study the learning process more nearly from its beginning. Activities used in laboratory studies include: card sorting, mirror drawing, tracing a maze, throwing darts at a target, holding a stylus on an oscillating target, sorting marbles by color, and picking up shot. Most of these experiments have been concerned chiefly with measures of learning in terms of changes in speed and accuracy of the performance resulting from practice while the factors of the external situation were kept constant. There have been comparatively few attempts to render a descriptive account of the progressive changes in the total action function that take place in learning. This has been due to the influence of the stimulus-response psychology, with its emphasis on physical stimulation and the end phase of the action. From this point of view, motor learning consists of building a connection between a sensory stimulus and a movement, and for that reason it has frequently been called *sensorimotor learning*.

The General Features of Purposive Action

In order to see how the total action function is modified under repetition we should first consider the chief features of action before repetition takes place. When a person undertakes to acquire skill in a novel task, his initial performances are usually purposive acts. The stages of a typical simple purposive act are: first, instruction; second, formulation of the task; third, progress toward the goal; and fourth, completion.

1. **Instruction.** This may occur by means of verbal directions, requests, or commands of another person. Such is the case in laboratory experiments when the experimenter tells the subject what to do, or in the classroom when the teacher tells a pupil to erase the blackboard. Sometimes one is instructed by the occasion. This occurs when a person apprehends an object or a situation as calling for "something-to-be-done" by means of bodily movements. The sight of the parched lawn instructs the home owner to get his hose out and give the grass the needed watering. This form of instruction may come through memory or imagination as well as through perception. The home owner, while sitting at his desk, may recall that there has been no rain for several weeks and reflect that the lawn must need watering. Instruction also comes from one's self, as when one chooses to go home a different way simply for the sake of a change of scenery.

2. **The task.** The task as a set that controls the sequence of movements in action has been described in an earlier section (chapter VI). It involves foresight of the end to be attained and an intent to achieve this end. It is a goal-set, and is commonly called *purpose*. We say that the individual has "made up his mind" to do a certain thing when he has definitely formulated a task. In the case of our lawn-sprinkling illustration, after observing the parched condition of the grass, our friend makes up his mind to water the lawn, and in so doing he formulates his task.

Probably, the most thorough experimental study of the functional changes occurring in action as a result of repetition is one made by Longwell (27*a*). She distinguishes three forms of the task: first, general; second, specific; and third, secondary. The general task is described as "an undetailed reference to a total and imminent problem." The specific task has to do with a particular phase of the total performance and is set up before the actual resolution-by-movement gets under way. The secondary tasks are sub-tasks having to do with details of the total performance, which are decided upon during the course of working out the problem by movements. To illustrate: One of the problems used in Longwell's study was to roll four small steel balls into a wire cage by manual manipulation of the box containing the balls and cage. The general task covered the entire performance of caging all four balls. A specific task was formulated when the subject decided to go after one particular ball. A secondary task appeared in reference to keeping three balls in the cage while the fourth one was captured. In the case of our home owner, when he decided to water the lawn, he had a general task. When he decided to turn on the water, he had a specific task. A sub-task appears when, upon attempting to pull the hose forward to reach a far corner of the lawn, he realizes it has become entangled in some shrubbery and returns to release it.

3. **Progress toward the goal.** In this phase of the action, steps are taken toward the solution of the general task. Secondary tasks are set up and resolved. The man with the lawn turns on the water and sprays one section after another. He gets near the far corner; the hose can be pulled no farther; the stream falls short. He then realizes that he does not have his nozzle adjusted for throwing the water the maximum distance. So he says to himself, or thinks, "Turn it to the right a bit" (secondary task). He does so and finds that the water shoots out to the far corner. As the individual moves through the course of resolving his task, he is aware of his moves and realizes that he is approaching his goal.

4. **Completion.** Finally, the individual reaches his goal. The task is completely resolved by means of appropriate final movements. There is a realization of having finished the job and a sense of relief and satisfaction.

Progressive Change in Action under Repetition

Repetition of an act normally brings about habituation. It does so by producing progressive change in various aspects of the total function. At various stages of learning and with various amounts of repetition we find different degrees of habituation. In considering the modifications which result from repetition we shall be concerned with changes in the following features: 1. the task, 2. perception, 3. determination, 4. accessory responses, 5. feeling tone, 6. integration, 7. speed and accuracy, and 8. fatigue effects.

1. **Changes in the task.** At the beginning the individual sets up general, specific, and secondary tasks. This means that he thinks of what he is to do in a general way, consciously selects particular movements to be made, and as he proceeds to carry out his task, he chooses and plans details and executes steps with reference to the anticipated end result. As the act is repeated, the tasks appear in various forms, due to revisions, abbreviations, and fractionations. Before long they tend to dwindle and eventually drop out altogether. Longwell (27*b*) found that the general task tended to disappear first, while the secondary task taking care of the various details in the course of the action persisted until a further degree of habituation was reached. In time, however, the secondary task also was eliminated.

The "dropping out of the task" means that the subject does not have to formulate the act in his mind. He does not have to design consciously the pattern of movements. He does not, as he confronts the situation, have to think, "Now I'll do this particular thing." The perception of the situation touches off without conscious intent or purpose the sequence of movements previously made. Thus, attention is freed from the details of the process of carrying out the act. This effects an enormous economy for the individual in getting things done, because his attention may be given to other matters while the habituated performance goes forward. In the case of writing a letter, the movements of the fingers and hand do the writing quite automatically while the writer's attention is free for the nonhabituated activity of thinking what to write. The habituated activity contributes to the total enterprise, which involves also nonhabituated performance (1*a*).

2. Changes in perception. In nonhabituated activity, perception plays an important role. As indicated above, it leads to the formulation of the task, and through it the learner is made aware of various objects involved in the course of action, of the various movements made, and of the changes in the situation effected by the movements. In the course of habituation, however, perception diminishes. First it narrows to those aspects of the situation most vital to the action. The perception of irrelevant factors tends to drop out fairly early. Then it is reduced with respect to those features of the situation of vital concern to the performance. In learning to play the piano, the novice sees each individual note. But with practice comes a reduction of perception. Bentley (1*b*) describes the process as follows:

> . . . Individual notes upon the staff are no longer apprehended as individuals. They come in groups and their meanings are group-flashes. Again, the individual determination which leads from this note or that note upon the score to this or that movement toward the appropriate black or white key disappears. After the group-flash comes, without intermediation, a sequence of rapid movements. Still later the score may wholly drop out of clear perception and serve as a vague and obscure cue to a complicated series of movements. The sound itself as it flows along may be the controlling object and then we have the curious fact of an action where the perceived object is the result of the action and not its antecedent. This stage informs us that the action is becoming automatized. That means that the original perception is dropping out.

In many skills where one's sequence of movements must be suited to changing aspects of the situation, as in automobile driving or in baseball, a residuum of attention is indispensable. One must watch the traffic and curves in the road. But the extent to which perception drops out in this activity can be seen by the fact that one may drive under familiar conditions with his mind absorbed in conversation or the topics of the day. The vaguest kind of perception, with reduced cues and obscure reference to the sides of the road or the traffic lines, enables the driver to keep his car on the road and in the right lane. Without conscious intent he turns the steering wheel upon approaching slight curves and depresses the accelerator as he comes to an upgrade. These movements, which were initiated by sub-tasks, issuing from clear perception of curves and hills when he was learning to drive, now follow the barest flash of perceptual meaning. Clear perceptions may emerge again as active participants in the performance when the driver encounters a traffic snarl or unusual road conditions, for here he is thrown back to a less practiced level of activity.

Because of the great amount of repetition of the acts involved in driving a car, the whole process tends to become automatized, and yet one cannot drive safely without being attentively alert. Lapses of attention, the normal result of automatization, constitute a threat to safe driving. They have been responsible for many accidents.

3. **Changes in determination.** The course of action is determined by sets, predispositions, and habit trends. Sometimes perception, memory, imagination, and search contribute to the determination by way of the task. This generally occurs when the individual is confronted by a new situation, or when he is called upon to act in an unaccustomed manner.

In the case of familiar situations and repeated acts, these functions have little or nothing at all to do with the determination. There are within the central nervous system sets and functional dispositions or conditions of readiness for certain modes of operation. These have been acquired from previous experiences and training, and possibly to some extent from heredity. Sometimes a perception alone, without the reference to the end that is found in the task, is sufficient to set off action governed by these neural tendencies. This happens, for example, when the experienced driver depresses the accelerator upon approaching a hill. In the reflexes and in highly automatized action mental factors seem to play no part at all in the determination of what is done. The determination is then altogether a matter of the neural trends.

Longwell (27*c*) found the determination arising from the task in all three of the problems used in her study. This occurred in the earlier stages of learning before the task dropped out. As the trials continued and tasks disappeared, there seemed to be no functional representation of determination in perception or thought. Moreover, the evidence indicated that under repetition of the acts, determination became more stabilized and less variable.

Thus, under practice, the control and direction of the course of action, the means of selecting appropriate movements and maintaining their orderly sequence, pass by degrees from the psychological functions to the neural functions, from mind to body, from the conscious to the nonconscious. The determination tends to become a matter of fixed and stable habits. This makes for stability and dependability of action. An action determined by a well-fixed habit tendency is less subject to disruption by distractions and emotional upsets than is purposive action.

4. Changes in accessory responses. The novice usually displays a number of responses which are more or less accessory to the action. Superficially, these appear to be irrelevant and mark the behavior of an inexperienced performer. Yet they are integral features of the course of resolution. They reflect the status of the performance at the moment and sometimes appear to effect changes in the procedure. The accessory factors include various comments, facetious remarks, giggling, squirming, sighs, exclamations, emotional reactions, self-instructions in the way of admonitions to be more careful or to try for speed and let the errors take care of themselves, and flashes of reference to self indicated by such questions as "How am I doing?" To illustrate these features of untrained action we quote from the record of the first trial by a subject in the mirror-drawing experiment. The drawing made by this subject in this trial is shown in the first star of figure 25.

> Trial No. 1. At the beginning S smiled, then laughed in embarrassment. "It's awful! I can't start to go in the right direction. Now, if I push it that way. . . . Oh, I'm only going back and forth. How do I ever go forward?" The hand of S, grasping the pencil tightly, shook as it bore heavily on the paper. Leaning over in a hunched, cramped position, S exhibited marked attention. Exclamations of disgust were frequent. Having gone around the first point, she remarked, "A little better!" There were sighs as she went along the side of the second point, making many errors. After tracing around the third point, she said complainingly, "Oh-oh, stuck again!" Her mouth was closed tightly. Just before the fifth point she crossed the line several times, exclaiming, "Oh, dear! I'm slipping out again!" According to her own introspective report, she felt "awfully hot!" Her attention, she said, was not steady because part of the time she was trying to think out the process; then she decided to pay attention. Her thoughts also dwelt on the instruction to keep between the lines. She was conscious of the fact that she was making many mistakes.

Under repetition these accessory responses tend to drop out. As this experiment went forward, fewer comments were made by the subject. In trial 14, the drawing of which appears in figure 25, there were no comments at all. There was a calm, businesslike demeanor, with uniform attention on the image of the star in the mirror. The subject reported that her hand was just "going of its own accord," and that she was "not being of much help to it." Accessory factors sometimes persist. In the thirteenth trial of this experiment, for example, the subject decided to take more time and try to make the tracing as perfect as she could (self-instruction), and a contortion of the face occurred during the tracing. Longwell (27*d*) reports that accessory factors did not drop out altogether but that they tended to disappear or to become stabilized as a result of repetition.

5. **Changes in feeling tone.** Actions are frequently toned by feelings of pleasantness or unpleasantness, by satisfaction and annoyance. These feeling tones, like other features of action, tend to change under repetition. In general, the feeling which accompanies an action shifts from the unpleasant and disagreeable to the pleasant and agreeable. The tensions, uncertainties, misgivings, awkwardness, and mistakes of the earlier tries are annoying, as are the distressing frustrations due to inappropriate sub-tasks, miscalculations, getting off on a wrong course, running into blind alleys, or the chagrin occasioned by one's ineptitude and the fear of being compared unfavorably with others. To be sure, a new action is not always unpleasant. Its novelty may provide the exhilaration of a new adventure, or the delight in being able to take the initial step toward a skill which brings happiness or monetary reward may outweigh the disagreeable elements. As a rule, however, a person finds it more satisfying to do what he is accustomed to doing, or what he has practiced and knows he can do well, than to engage in an untried form of action or to struggle with a task that is unfamiliar. This is probably why our lives become so ruled by habits, why we get into ruts. We tend to do things day after day in the same manner. The adoption of new ways is too disturbing to our comfortable complacency. With practice, training, and the resulting cleverness come confidence, self-assurance, pride in ability, satisfactions of success, and sometimes even the sense of superiority.

6. **Integration of movements.** In action the tasks are resolved by means of bodily movements. Of the various features of action, the movements are most easily observed. They may be observed and measured in the other person, whereas to study the other features which we have been discussing we must rely largely upon reports by the

person who is doing the acting. This greater accessibility of movements for observation has been responsible, no doubt, for the preponderance of attention given to this aspect of action in experimental studies. This is particularly true of those studies in which the strictly objective methods of the behaviorist have been employed. Indeed, it is easy to fall into the error of failing to see anything in action but the motions made.

Under the influence of repetition the movements undergo considerable transformation. In the beginning, as one undertakes to develop a motor skill, his movements are likely to be jerky, hesitant, clumsy, and awkward. The individual fumbles in his attempts. He tries out various movements to see whether they will help. The movements vary from trial to trial. They are separate, nonligated units of the total performance with their own antecedent sub-tasks. As practice proceeds, the useless movements drop out and digressions are eliminated. Those movements that prove useful in bringing the person to his goal are made with greater promptness and precision, and become ligated into a smoothly flowing sequence. The performance becomes unified, stable, and highly integrated.

Various attempts have been made to explain the integration of the successive movements of a complex performance. Watson (47) offered the chain reflex theory according to which the kinesthetic impulses aroused by one movement come through practice to release the succeeding movement. The motor pattern was regarded as a chain of movements in which each movement set the next off in turn. The inadequacy of this explanation has been demonstrated by work done since Watson put forth his theory.

That a habit can be built and controlled kinesthetically has been demonstrated by Hunter (21). He used five rats and a block-type elevated maze. The rats were blinded by surgical operation. The maze was rotated and the sections of the maze were interchanged during the learning, making it impossible for the rats to obtain cues from the maze or its surroundings. All five rats succeeded in learning the maze to the point of three successive perfect trials.

Other experiments have shown that the rat uses visual, auditory, and olfactory cues when they are available (26, 39). Honzik (19) compared the maze learning of normal, blind, deaf, blind-deaf, blind-anosmic, and blind-deaf-anosmic rats. The deaf and anosmic rats learned about as well as the normal. They and the normal rats were definitely superior to each of the blind groups. Blindness reduced the ability to learn somewhat but when it was combined with loss of hearing, or loss of smell, the learning was still more inferior. The rats deprived of smell, sight, and hearing did the poorest of all.

These experiments are mentioned here because they indicate the importance of the kinesthetic and exteroceptic cues to the smooth on-running of a series of movements linked together during practice. It appears that not only the kinesthesis aroused by a movement but any cue to which this movement brings the performer may serve, after practice, to set off the next movement in the series. Since they immediately precede or occur with the sub-tasks for the following movements over and over again during the early stages of practice, they eventually become conditioned stimuli for the movement which follows (18). Each movement or some consequence of it becomes the adequate means for initiation of the next step.

Overlapping. Writers have stressed the significance of overlapping of the units of action. *Overlapping* means that after some practice with a movement-by-movement procedure, the learner, before he has completed one unit of action, starts on the next one. When still in the stage where each move has to be thought of, he can, while executing one movement, anticipate or formulate the sub-task for the next. Therefore, the stimuli arising from the movement occur repeatedly with the factors initiating the movement that follows. By conditioning, then, one phase of action supplies the means for touching off the next, and it is no longer necessary for the person to think of each successive motion.

The best examples of the welding together of initially separate movements into unified patterns or higher units are found in those skills where each repetition of the performance involves the same movements in the same sequence. Playing a particular piece of music, typing certain words, or sending words in telegraphy are examples.

Higher units. In learning to send messages by telegraphy, improvement depends largely upon developing *higher units* of action. The learner must begin by learning to make the movements that produce the dots and dashes standing for each letter. These at first are made as discrete movements but the constant repetition of the series for each letter soon enables the sender to tap out each letter as a unit. He does not have to think of each movement, but only of the letter. Here the letter unit is a higher unit when compared to the separate movements involved in tapping out the letter. The learner may continue for some time on the letter-sending level, spelling the words and tapping out each letter as a separate act. As the letter units become familiar and more automatized through practice, they are made with greater ease and while the movements for one letter are still in progress, the sender's attention reaches ahead to the next letter. The second letter-unit of action then is actually begun before the first is completed. We then have overlapping. Soon the letter habits are tied together into action units incorporating all the movements for whole words. Then the sender does not have to think of each letter as he taps out his message. He has passed from letter habits to word habits. Thinking the word "arrived" sets off the rhythmical unified pattern of finger movements for the whole word.

In typewriting, each particular word always calls for the same series of key-tapping movements. At first each word is spelled out and each letter is struck as a separate act. As practice continues with the same words, the letter habits become well-established. Writing, however, at this stage is relatively slow. Improvement in speed is not achieved by a huge effort to work faster. Such an attempt to force increase of speed may only result in confusion and actually impair the quality of the performance. Further improvement demands better methods. It is achieved by passing from the letter-habit stage to the word-habit stage. When the point has been reached where the separate letters are tapped out easily, the learner, while striking one letter, is thinking of the next letter and locating the position of its key. Thus, letter units of action begin to overlap. A foreshortening of the process of writing the whole word takes place and after a time the word unit emerges. The movements made in the discrete acts for each letter are still made, but now they are all made as one act. This process may go still further in the incorporation of word units into simple phrase units.

This process of integration of simpler action units into higher units is seen also in learning to shift the gears of a car. Here the same order of movements is repeated time after time. The beginner has to think of each movement to be made. He must first memorize the sequence so that at each step he can think of what to do next. But the skilled driver has only to note that the traffic light has flashed green to have the whole series of gear-shifting movements run off automatically while he keeps his eyes and attention on the other cars.

In considering this matter of the integration of the discrete units of a total action function, it should not be assumed that there is no framework to hold these units together at the beginning of practice. Building a skill is not merely the adding of one movement to another. There is at the start the purpose, or the general task, which envisages the goal of the total performance. The various units of action are steps taken to reach this goal. The selection and integration of certain movements and the elimination of others is a matter of their congruity or incongruity with the individual's aims. Repetition affords the opportunity for developing better methods of accomplishing that which is to be done.

Some skills, moreover, do not involve a fixed order of movements such as we have described above, or at least a fixed order of movements is found only in segments of the total. In the case of card sorting, each throw is dependent on the markings of the card uncovered. There can be some overlapping in that the subject may look at the next card while throwing the card in hand. But it must be his perception of each card that determines which of several movements is to be made. Since the cards are shuffled for each trial, no chain of throwing movements can be developed here. Facility in this performance is derived from not having to think or look each time where a particular card is to be placed. Through practice the perception of the card is reduced to a minimum, and it releases promptly the determination of the movement. Such sensorimotor skills, where the movements do not follow a fixed order, are found in driving a car through traffic, typing unfamiliar copy, and in playing tennis. The succession of appropriate movements depends upon the shifting aspects of the external situation. Since these are unpredictable, the performer must constantly "keep his eye on the ball."

7. **Speed and accuracy.** As a consequence of the changes we have been considering there is usually an increase in the speed and accuracy of performance. The typist writes faster and with fewer mistakes. The tennis player lets the high balls go by, and thereby wins a point, where the novice tries for them and loses. The driver reacts in an emergency quickly enough to prevent the threatened crash. The mail dispatcher does not require so long to sort his letters and he throws them into the right sacks. The skater glides smoothly and swiftly without losing his balance. The trained worker gets more done with less effort and does it better. The smooth and rhythmical movements of the skillful dancer flow on in charming gracefulness.

An example of reduction of errors in motor learning is presented in figure 25, in the reproductions of the tracings of star outlines by a subject in the mirror-drawing experiment.

Mirror drawing provides a good example of sensorimotor learning, and it is well suited to experimental study. It presents a novel task, and, in a conveniently short period of time, one can observe the stages and changes characteristic of this form of learning. Since it is easy to record the time required for each drawing and the number of errors made in each, we are able to evaluate the successive trials in terms of speed and accuracy and, thus, obtain a definite measure of the improvement that takes place through practice.

In the experiment from which these drawings were selected, the star forms were placed on the baseboard of the apparatus and a shield was adjusted so that the subject was able to see the star only by looking into the mirror. He was instructed to trace the star outline by drawing a line along the path between the lines of the star. An error was defined as touching or crossing the line on either side of the path. Fifteen stars were traced. The first two and the last two are shown in figure 25. A comparison will show the extent of improvement in the subject's ability to keep within the lines. The error scores for the first, second, fourteenth, and fifteenth trials respectively were 92, 51, 10,

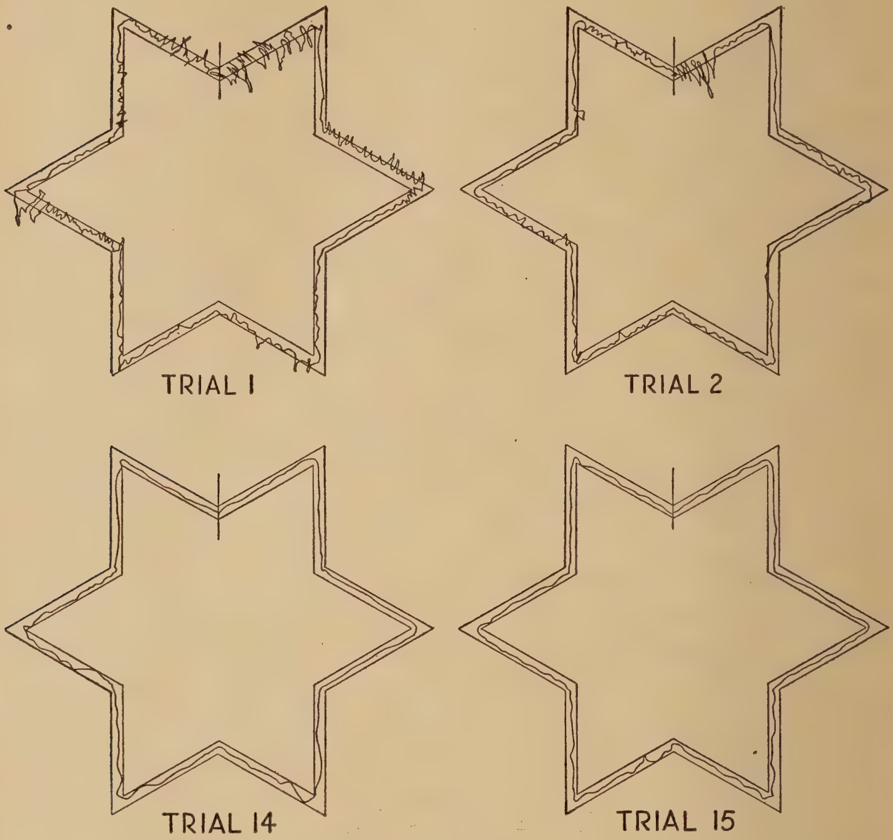

Fig. 25. The tracings of the star outline made by one subject in the mirror-drawing experiment. The drawings for the first two and the last two of fifteen trials are shown. The stars were five inches from tip to opposite tip, and the distance between the lines was one eighth of an inch.

and 4. The time scores in seconds for these trials were 440, 276, 70, and 75.

The reduction of time and errors with practice is shown graphically in figure 26. The curves are based on the average scores for each trial made by fifty students. The dotted line is the curve for errors; the solid line is the curve for time scores. Improvement in both speed and accuracy is indicated by the steady decline of the curves throughout the fifteen trials.

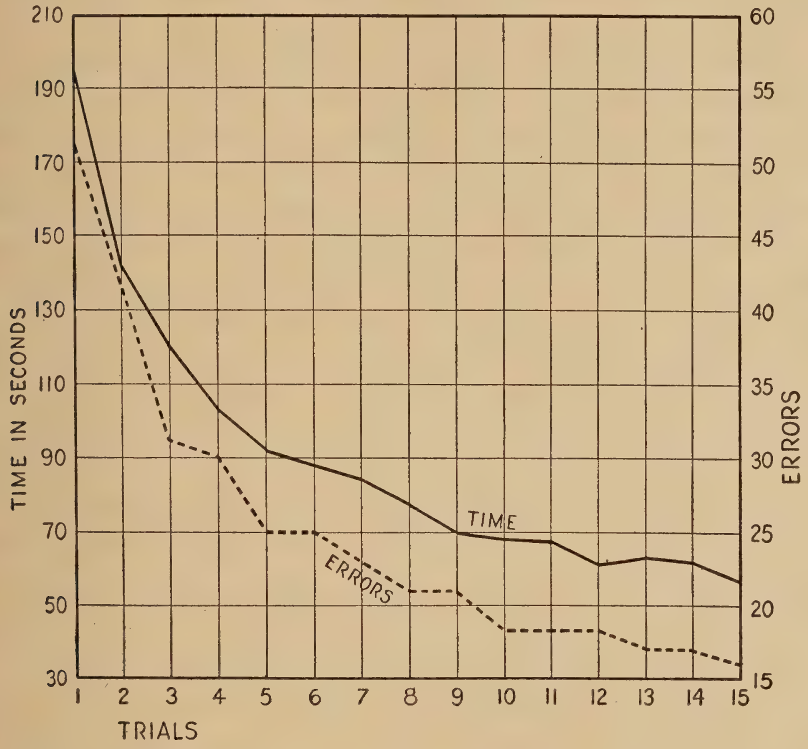

Fig. 26. Learning curves for time and errors, based on the mean scores of fifty subjects in the mirror-drawing experiment.

8. **Changes in fatigue effects.** As a rule practice reduces the amount of fatigue resulting from performing a given task. We refer here, of course, to the fatigue produced by a single performance, not the cumulative effects of a long series of trials. Early trials are sometimes very exhausting. One is likely to begin with a great deal of muscular tension; nervous energy is dissipated; and effort is wastefully expended in surplus motion. Energy is consumed by anxiety and fear. In the practiced performance, energy is expended more economically; there is less wasted effort, and futile digressions are not so likely to

appear. The skilled performer is less subject to loss of energy through distractions and emotional disturbances. He takes his work more calmly and performs it with greater ease. A person's first day's work on a new job is likely to leave him pretty well worn out. It is difficult for a teacher to realize how fatiguing are the child's first exercises in penmanship. The experienced teacher will appreciate this point if he will recall how tired he became on the first day he taught in school.

Economy and Efficiency in Motor Learning

The preceding section was devoted to a description of the changes in the action functions that occur under practice. We shall now consider some of those factors that make for efficiency and economy in acquiring a motor skill. The factors to be considered are motives, working conditions and equipment, the correction of faulty performance, and some essentials of effective practice. Since guidance by an instructor is a factor of prime importance to economy and efficiency of learning, we shall consider, in discussing these topics, some of the ways a teacher may effectively promote this kind of learning. It should be remembered, however, that psychology approaches the problem of learning from the standpoint of the learner, not from that of the teacher. Courses on teaching methods approach the subject from the teacher's standpoint. From the point of view of this volume teaching practices are aids to learning.

Motivation. Adequate motivation is always an essential for effective learning activity. When it is a motor skill that is to be acquired, probably the best motive is the desire to possess the skill. Before he can desire a skill or feel a need for it, the learner must appreciate its value. When there is no such desire, the teacher's first concern is to create it if possible. In many cases it will be sufficient to point out the benefits to be derived from the skill. If the learner is a younger child and the advantages offered by the skill are so remote that they do not appeal to him, then other motives must be enlisted. Among these are the desires for social approval, prestige, and play. The enlistment of these motives calls for the use of incentives. If, for example, a young child is learning to write, he might apply himself earnestly in order to take home specimens of his work to show his parents how well he is doing. The resourceful teacher will think of many ways to arouse interest and secure active effort.

Instruction and motor learning. For the efficient use of time and effort in motor learning the learner should have, in addition to the desire to learn, a definite and clear conception of what procedures will lead to the desired results. If he does not know what to do and how to do it, he must either get this information or resort to the clumsier and wasteful method of manipulative exploration. At this point, the teacher is able to make an important contribution to the economy and efficiency of motor learning, for proper instruction serves to curtail the waste of time and energy which the trial-and-error procedure involves. The writer once demonstrated this point by presenting a form board test to two children of approximately equal ability. To one of them he gave the standard instructions only. This child spent nearly five minutes getting the blocks into their proper positions. There was a great amount of trial and error. There were many false and hesitating movements. Blocks were placed, then withdrawn, and tried out in other positions. The other child, after the formal instructions were given, was told, "Now I am going to show you just how to do it. Watch me carefully and try to put the blocks in just as I do." After the demonstration, this child put the blocks in their proper places without a single error, and completed the task in less than one minute. Here was a simple demonstration of the fact that it helps tremendously in some kinds of learning to have someone show you how to do what you wish to learn to do.

In the absence of an instructor to point the way, the more mature learner may profit by reading books of directions. It would be disastrous for one to attempt to operate certain machines without any knowledge of procedure at all. If one were to try to start an automobile in complete ignorance of the necessary steps, he probably would ruin his car before he could discover them. In some cases if the learner possesses the ability and inclination, he might be able to think out an adequate procedure, though in actual practice this is not often done. Observing and studying the methods of experts may provide valuable suggestions to a novice, but this is likely to be insufficient. The swift, smooth, and clever finished product of learning may conceal the very steps essential for the novice to take and practice before he can approach the performance of the expert.

The contributions of instruction. It is important that we see clearly just what instruction does and does not contribute to the efficiency and economy of learning. It is a valuable source of information regarding what to do and how to do it. It gives knowledge but not skill. The skill must be acquired by the learner through his own practice. A child will never become a good writer merely from listening to the teacher's explanation of the way to hold the pencil or how to form this or that letter. The student of violin will never become a great player by merely reading books on how to play a violin. Skill in teaching does not come from taking education courses in a university. One acquires skill in teaching, as in other skills, by practice—by actual teaching. But instruction shows one what to do and ways of doing it, and thereby aids in the acquiring of a skill. It may prevent wasteful and harmful experimentation. As a colleague once put it in addressing his class in a course on education, "We are trying to keep you from doing more harm than is necessary while you are learning to teach." Good instruction in motor learning helps the learner to formulate appropriate tasks and sub-tasks. These determine what he does and how he learns.

Reflective thinking and motor learning. In the absence of knowledge of how to proceed when one undertakes to develop a new type of skill, and with no one to give the learner directions, it would seem that an individual might in some cases be able to think out the proper procedure and thereby save himself from the less efficient manipulative exploration of a trial-and-error attack. Perhaps this is sometimes done, though it is probably safe to say that it is rarely done. To think out the best method of performing a task requires a certain amount of knowledge or experience relevant to the task, an acquaintance with principles involved, and the ability to restrain the impulse to experiment blindly. It is probably more often the expert or a person who has already acquired some proficiency who actually thinks out a better way of doing a thing than the novice. Repeatedly, students have reported that prior to their start on the mirror-drawing experiment, they thought that they could manage the tracings easily by simply going in the opposite way from that which was normal because they were aware of the fact that the mirror reverses the image of the star outline. Here is an example of trying to solve the problem of procedure by thinking. But the actual benefit of such reflections is invariably slight. Usually the subject soon becomes baffled and finds that his deductions lead only to confusion. He then casts aside his logic and plunges into a try-this-and-try-that method.

When reflective thinking is helpful, its contribution is of the same sort as that made by the instruction of a teacher or of a book. It provides suggestions of how to proceed. Of itself it can never yield a motor skill. It is, in fact, a source of self-instruction out of which grows the task or sub-task which governs the learner's reactions. It may, if good, foreshorten trial and error and thereby contribute to the efficiency of learning. The development of skill, however, requires practice on the part of the learner.

Guidance at the Start of Learning

Initial instruction. In order to acquire a motor skill efficiently a correct start is of great importance. One is fortunate if he has a good teacher or coach to direct his efforts at the beginning. Proper initial instruction will not only save the learner's time but will help to prevent the development of bad habits, which may be formed by the untutored. Wrong habits established as a result of faulty methods employed in the early stages of learning prevent the attainment of a high degree of proficiency and are often overcome only with great difficulty.

Adequate instruction for a good beginning involves more than placing before a child a perfect model or completed sample of a product of the skill he is to acquire. A child may desire to write and may have as his goal the acquiring of the ability to write. But when he begins, he must start by making particular letters. His ultimate goal must be reached by way of achieving sub-goals. In order to become a good writer, he must learn to make the letter *a,* and the letter *h,* and all the rest. Now suppose we hand him a well-written copy of the letter *a* and merely tell him to reproduce it. He may draw a rough likeness of what he sees but his methods may be altogether bad as a foundation for skill in writing. With a specimen of writing before him and with no direction except to copy it, there is no particular reason why the child should not begin to write at the right-hand side of the page and work backwards. He might build up his reproduction in sections, making a figure *8* by drawing two small circles one above the other, or the letter *R* by drawing a circle and putting two legs on it. These are only suggestions of the many faulty habits a small child might form if left to learn to write without instructions about how to form his letters. For a good start, he must be taught what movements are necessary and the sequence in which they should be made. This calls for directions with explanations and demonstrations.

In some cases of motor learning a clear verbal explanation, simply telling the learner what to do and how to do it, may be sufficient, depending upon the learner's ability to grasp and retain the instructions. This will require a background of experience or knowledge sufficient for comprehension of what he is told, adequate attention to the explanation, and a memory for the essential details of the instructions. Thus, an eighteen-year-old who has ridden with others in a car might be able to fix in his mind the necessary procedure for starting a car from verbal directions either oral or printed. But an adult who has had no acquaintance whatsoever with the language of golf would probably be baffled if his instructor in his first lesson in golf tells him he must play his iron shots off the center of the body and that he should keep his stance slightly open. The essential purpose of the initial instruction is to give the learner a clear idea of what he must try to do. If verbal explanation and directions are not sufficient to accomplish this, the instructor must show the learner. Since a young child is less capable of strict attention than a mature person and since his ability to comprehend and remember what he is told is more restricted, he, more often than an adult, will need to be taught by means of demonstration.

In giving a demonstration of the performance to be learned, the instructor must take care that his pupil is in a position to observe the essential details of the demonstration and that his attention is being given to it. It must not be hurried, but should be given slowly enough for each step to be witnessed and understood. In the case of a demonstration involving several steps it may be necessary to repeat it several times. In most cases explanation should accompany the demonstration.

A common mistake of an inexperienced teacher is to cover too many details in a single explanation, to give too many directions all at once, or to demonstrate more than a beginner can possibly assimilate at one time. The instructor should remember that the role of his instruction is to establish a set in the mind of the learner—a task—and that the capacity of any person is limited with respect to the number of steps that can be incorporated into a single task (page 103). It is poor teaching, for example, to take a young person out for his first lesson in driving a car, and proceed to tell him all you know about handling a car. He will not be able to remember more than four or five items of instruction at a time. The complex processes must be taken up a few steps at a time. As these are practiced and mastered, new steps can be added and the whole process integrated by practicing all the steps together.

An example of a good procedure in teaching a complex skill is taken from the case of a father who successfully taught his two sons to drive the family car. The first lesson consisted in getting used to steering the car. The father drove with his son to the top of a hill in a section where there was little traffic. The engine was turned off and the gears put in neutral. The learner's first experience behind the wheel consisted of releasing the brakes, steering the car as it coasted downhill, and applying the brakes at the bottom of the hill. This was repeated several times, the father driving each time back to the top. In the second lesson this was repeated a couple of times and then the second step was taken. This included turning on the switch, throwing out the clutch, setting the gears in low, and starting and driving in low gear only. In subsequent lessons complete gear shifting, driving in second, in high, backing, turning, and backing into a parking space were taught and practiced. The later lessons included the more difficult steps of starting on a hill without backing, and making a left turn uphill where it was necessary to shift from high to intermediate gear while making a turn. Each new lesson was opened with a review of all the preceding steps. The boys had no accident and easily passed their tests for driver's license.

Reversed view of the demonstration. A demonstration of a motor performance may be very confusing if the instructor and learner face each other. The reason for this is that the learner in such a position sees the movements in a right-left reversal of the way he must make them himself. The reader may observe this difficulty if he faces someone who is trying to show him how to tie a new kind of knot. It will be much easier to see how the knot is tied if he stands beside the demonstrator so that he can see the movements from the direction from which he will see his own movements when he attempts to tie the knot himself. An instructor of surveying reports that his students learn to use the surveying instruments more readily if he has them stand behind him and look over his shoulder as he gives his demonstrations.

Manual direction. Sometimes in teaching a motor skill manual guidance of the learner's movements is employed by the instructor. This procedure involves taking hold of the learner's hands, feet, or whatever part of the body he is to use in the skill to be acquired and pushing them through the desired movements in the proper sequence. In the case of handwriting such a procedure would be to take hold of the child's hand and push it through the movements required to make various letters. Piano teachers sometimes use manual guidance in placing a child's hand in position and pushing his fingers down to strike the keys. For beginners in manuscript writing the letter forms cut from emery paper are sometimes used. The child traces these forms with his fingers. In the first trials his hand may be guided manually by the teacher.

The merits of such practices must be determined from results obtained. Any practice which will help the child realize more clearly what movements he is to make would appear to be psychologically sound if it does not encourage faulty habits. In the first place the actual contribution of manual guidance should be clearly understood. What we have here is a form of demonstration. It is a way of showing the learner what to do and how to do it. As a form of demonstration, it has certain advantages over merely observing the teacher's performance. It avoids the difficulties of a reversed demonstration described in the preceding section. The learner sees his own members moving in the manner in which he must make them go himself. This should be helpful in selecting and identifying the proper movements and in determining their rightful significance.

There is another possible advantage of this kind of demonstration and that is the kinesthetic element involved. The child not only sees his hands or other members in the various positions but also feels them there and feels the movement from one position to another. The value of this is somewhat uncertain since the kinesthesis involved in having someone else move your arm about cannot be identical with that which comes from your own execution of the movement. Some individuals seem to depend on kinesthesis more than others in learning movements. A student in the writer's laboratory was found to be entirely lacking in visual imagery according to all our tests. She was given a learning problem that consisted of reproducing a nonsense design after a five-second exposure. Most students have been found to make a reasonably good reproduction after four or five trials. This student was unable after many trials to make any headway in learning the design well enough to reproduce it. Finally, she adopted the scheme of tracing the design in the air with her finger during the exposure period. By doing this she was able after three trials to make a very good reproduction of the figure. It is possible that such persons more than the visually minded might profit by manual guidance. This question calls for more adequate research.

It has been claimed, moreover, that manual guidance may be helpful for little children who have a particularly difficult time in trying to copy a performance they observe in another. Of course little children should not be called upon to do things which are too difficult for the level of maturation attained. But apart from this their first attempts may be so far from the standard set by the teacher's demonstration as to be extremely discouraging. The teacher must avoid creating a sense of inadequacy or hopelessness in the initial stages of learning. If for a young child the manual guidance of his hands in showing him how to do something helps to promote a sense of security or confidence, it will be worth while as a temporary expedient.

It should be remembered, however, that while manual guidance may be, in some cases, a good way of showing the learner how to carry out the performance, it does not take the place of the individual's own efforts and practice. To learn a skill is to modify the controls or determination of movements involved in the action. The center for these controls is in the central nervous system, and the modification of them is brought about by the learner's activity, not by the activity of the teacher.

Directions should be positive. Experimental evidence and teaching experience indicate that when a child is being directed concerning the form his activity is to take, he should be told what *to* do rather than what *not* to do. From the instructions arises the task which determines the course of action. The instructions, therefore, should be aimed at the results desired. Negative instructions may serve to inhibit undesirable responses but when imposed upon the child as he is about to enter upon a new kind of motor performance, they may serve to distract and divide his attention and lessen his chances of success. Direct measures must sometimes be taken to block error and break up faulty methods, as we shall consider later, but in the beginning, when we are trying to help the child to a good start, his attention should be directed to his goal and the movements to be made in order to reach it rather than toward the undesirable or forbidden modes of response. The best way to prevent the formation of faulty habits is to have a strong set and undivided attention directed toward the correct means of gaining one's end.

The matter of form. The best procedure for acquiring a motor skill usually involves certain matters of bodily adjustments, posture, and ways of grasping the instruments. These features of a performance are called *form*. Good form is essential for attaining the highest possible degree of excellence. A learner may know what he is supposed to do, he may have the right objective in mind, but with poor form his performance is likely to be poor and improve little under practice. In typewriting one may acquire some degree of skill by watching the keys and by tapping with only two or three fingers. Experience of experts indicates that the use of all five fingers of each hand is conducive to a greater degree of efficiency and that it is good practice to use certain fingers to strike certain keys. Most skills can be developed more rapidly and to a higher degree of proficiency if the learner knows and follows certain rules of form, which have been developed from the experience of experts. In ignorance of these matters the learner, if left to his own devices, must discover them as best he can through trial and error; or failing to discover them, as is often the case, he must struggle along on a plane of achievement far short of the skill which he might have reached had he known and practiced the best form. Fortunately, the knowledge of the best ways of doing a thing, gleaned from experience of experts, may be taught by a teacher or coach to the great advantage of the learner.

Every skill has its special brand of good form. The good carpenter knows how to strike a nail with the hammer so as to utilize to the fullest the weight of the hammer to drive the nail. The baseball pitcher knows that the way he grasps the ball has a great deal to do with the success of the throw. Even in pitching horseshoes there are ways of holding the shoe which influence the score. An acquaintance of the writer, inexperienced in golf, was invited by a friend, who was a good player, to spend an afternoon at the game. He knew that the ball was to be struck by the club. He knew the direction in which the ball was to be driven. His aim was not bad, for the ball started in the right direction. But to his consternation it curved, time after time in its flight, to the right and landed in the rough. Realizing something was wrong, but being unable to discover what, he appealed to his friend for advice. After watching his next play, the friend said, "Try holding the club like this," and demonstrated a grip with the hands well over on the top of the club so that the "V" formed by the thumb and forefinger of the right hand pointed toward the left shoulder. The novice had been gripping the club so that the right hand was at the side of the club with the "V" pointing toward the right shoulder. Following these directions did not produce expert shots, but it did result in an encouraging reduction of slicing.

Besides the manner of gripping the club, in golf we have the matter of stance, backswing, downswing, and follow through. On the backswing, for example, we are told by the professional that the club should be brought back slowly with the right elbow kept close to the body. At the finish of the downswing, he says, the weight should be entirely on the left foot and the arms and hands should follow through in line with the flight of the ball. The position of the feet, we are told, should be such that the line joining them will be parallel to the direction in which the player wishes to send the ball.

In learning to play the violin the pupil is instructed to keep his left wrist curved. The beginner at the piano is taught to hold his hand in a position parallel with the keys. The handler of freight finds advantageous ways of tilting and gripping heavy boxes. The juggler who keeps several balls in the air at once knows the trick of throwing the ball from a position to one side of its line of fall in order to keep it from colliding in the air with the others coming down. And so on, in tennis, basketball, ping-pong, swimming, fly casting, painting, dancing, bandaging wounds, and all the various skills, there are important matters of form which, if mastered at the beginning through the aid of one who has been through the process, will greatly increase the effectiveness of the learner's efforts.

A boy in the fifth grade was writing very poorly. The writer observed him carefully and discovered that he was gripping his pencil very tightly with his forefinger high up on the top side and bent inward at the first joint. The thumb extended farther down than the forefinger and the hand in general gave the impression of strain and cramp. The boy's writing was bad because he had not learned the proper way to hold his pencil. After he was instructed on this point, his writing improved. For best results in handwriting the forefinger should rest comfortably on the top of the pen or pencil and extend a little farther down than the thumb. The hand should be free to slide lightly along on the third and fourth fingers. The forearm should form an angle of approximately 90° with the line of the writing. The left side of the paper should form an angle of about 30° with the edge of the desk. These are some of the matters of form that should be taught to children in the penmanship class.

Working conditions and instruments. Favorable working conditions and good tools or instruments have much to do with efficiency and economy of motor learning. Room temperature and humidity should be conducive to bodily comfort. Lighting should be adequate for clear vision without strain. The height of chair, desk, or table used should be adjusted to avoid fatiguing positions. Instruments should be placed within natural reaching distances and, where several are used, arranged so that a minimum of effort is expended in shifting from one to another.

Poor working tools may retard learning or, because of necessary adjustment required to offset their defects, they may even be the source of habits that may later have to be overcome. In learning to write with a pen a child should not have to contend with a scratching or blotting pen. The beginner in typewriting should have a machine that responds normally when the keys are struck, and the child learning to play the piano should have an instrument that is well tuned.

Securing Improvement from Practice

A good start will do much to hasten learning. But even when one has had the benefit of clear instructions and good demonstrations, and when there is a real desire to learn, the early attempts are likely to result in relatively poor performance. False moves and a general diffusion of effort cause disappointment, strain, and fatigue. Anxiety of the learner is accompanied by tensed muscles that fail to coördinate. The learner may forget some of the instructions and resort to trial and error at various points. To secure improvement he must eliminate the false motions, reduce tensions, substitute efficient responses for awkward and clumsy methods, correct and dispense with errors, and coordinate those movements suited to bring him to his goal with the least effort and in the shortest time.

The statement sometimes made that we learn by making mistakes is only a half-truth. We must profit by our mistakes, and to do so we must recognize them as mistakes and avoid repeating them. If the learner has a definite and well-established goal, errors that are recognized will usually be annoying, since they mean that he is off the track or has missed his aim. It will not be necessary to scold or punish the child who is eager to learn in order to get him to correct his errors. For him the realization that he is not getting the desired results will be sufficient punishment.

It often happens, however, that the learner may not recognize his mistakes or understand what is wrong with his imperfect performance. It is here that the teacher may render effective service in guiding and promoting improvement by pointing out the mistakes or other features of the performance that need correcting.

Knowledge of error is essential to improvement. In chapter V mention was made of an experiment reported by Thorndike in which the subject attempted 3,000 times to draw a four-inch line with his eyes closed. No improvement was made as a result of all these trials because the subject did not know the extent of his error in the various attempts. It seems unlikely that anyone in such a situation would be able to make any real gains. But suppose the subject were informed after each trial just how far short or how much over four inches he had drawn his line. We should then have a different sort of situation, and an essential condition for improvement would be provided. This was demonstrated in an experiment carried out in the writer's laboratory.

Three groups of students were used as subjects. Seven subjects in group A_1 were asked to close their eyes and draw a line four inches long. This was repeated until each subject had drawn 400 lines without opening his eyes or once looking at his drawings. No information was given at any time regarding the success of the attempts. The average error for the first ten trials for all seven subjects was fifteen sixteenths of an inch, and for the last ten trials of the 400 it was thirteen sixteenths of an inch. The variations were so great, however, as to make this slight gain wholly insignificant. Some subjects drifted a bit nearer the goal while others were making larger errors at the end of the 400 trials than they made at the beginning.

The members of this same group (A_2) were then given twenty-five more trials, but after each attempt they opened their eyes and placed a four-inch strip of cardboard along the line they had just drawn. It showed at once just how much the line was too short or too long. Under this procedure the improvement was rapid during the first few trials. It will be noted that this group had just had the 400 trials without check on errors. Therefore, the first trial of this series was actually their 401st attempt. In this, their mean error was 21.4, while in the first of the 400 trials their average error was only 16.1, the unit of measurement being one sixteenth of an inch. After 400 trials with no check on errors they were doing worse than when they started. But after only four visual checks on their performances they reduced their errors to only 2.9.

To avoid possible complications due to the effects of the first series of 400 checkless trials, and to compare two different methods of informing the subjects concerning their errors, two additional series of trials were conducted with two other groups. After each line was drawn, the members of group B opened their eyes and checked their errors with a four-inch strip of cardboard. Members of group C kept their eyes closed but after each line was drawn, the experimenter measured it and announced the extent of error in sixteenths of an inch and stated whether it was over or less than four inches.

The mean error scores in sixteenths of an inch for the 1st, 5th, 10th, 15th, and 20th trials in the four series were as follows:

Group Check	A_1 None	A_2 Visual	B Visual	C Auditory
Number of subjects	7	7	14	15
Mean scores				
1st trial	16.1	21.4	21.6	22.0
5th trial	15.9	2.9	6.2	6.7
10th trial	11.4	2.7	4.4	4.1
15th trial	13.0	4.7	3.1	5.3
20th trial	17.3	2.2	2.0	3.7

It will be observed that the average score of the group that had no check on the nature and extent of its errors (A_1) was actually poorer for the 20th trial than for the 1st, while with a clear and definite check on errors after each attempt all three groups made rapid gains during the first five trials. A slight advantage appears in favor of the visual check, in which the subjects checked their lines themselves, over the auditory check, in which the experimenter measured the lines and informed the subjects of their errors.

Some faults are not easily apprehended. In the experiment described above the deficiency of each performance could be definitely observed and precisely stated. The mistakes in typewriting, due to striking the wrong letter, may be easily seen by the pupil himself. In shooting at a target the exact deviation from the bull's-eye may be measured. In the mirror-drawing experiment the errors, being defined as touching either line bordering the path to be traced, can readily be noted. In many skills, however, the imperfections in one's performance may not be so easily discerned. In some cases it may be difficult for the teacher to get the child to see in what respects his performance falls short of the desired standard. There may be faults due to lack of coördination, or deviations from the goal that the learner, because of his inexperience, cannot detect or even see when the teacher attempts to point them out to him. Such may be the case, for example, with the young violin player. He goes through the required motions but his music lacks the refinement of good timing, or some other less tangible quality. For such conditions the teacher must have patience, and the pupil must have the benefit of good examples and adequate demonstrations repeatedly given in order to refine his conception of the goal and sufficient practice to provide the opportunity for improvement.

Punishment, emphasis, and extraneous cues. It is a common practice in training animals and children to punish undesirable forms of behavior. The belief behind this practice is that the unpleasant after-effects of an act tend to prevent its recurrence. As noted in chapter VI, many experiments have been performed with animals to determine the effect of punishment for "errors." It has been found that an electric shock accompanying wrong responses generally serves to hasten the elimination of errors. The explanation in terms of the law of effect was that the tendency to make the wrong responses was weakened by the annoying result. This explanation has been proven inadequate by recent studies, which have shown that shock on right responses or in an alley between turns also tends to facilitate learning. These findings have led some writers to believe that the effect of the shock is not to inhibit the wrong responses but rather to make the learner more alert to the significant cues and to emphasize the fact that the response is either right or wrong (34). Muenzinger concluded that the effect of the shock was general rather than specific (30).

Bernard and Gilbert (2*a*) report an experiment on maze learning with fifty-two college students as subjects that was designed to determine whether the effect of shock on entering blind alleys was general or specific. They found that the alleys in which shock was received were eliminated more readily than those in which no shock was received. From this they concluded that the shock did have a specific effect in modifying the reactions it accompanied as well as the general effect on the learner's alertness demonstrated by other studies.

These writers also point out that the use of the words *reward* and *punishment* may be misleading in considering the effect of extraneous stimuli on learning. For a stimulus which may be annoying as a signal that an error has been made may be satisfying when it means that a right choice has been made. Shock when used to announce errors usually has punishment value, but it has been found to have about the same effect as a reward when used on right responses (42). Bernard and Gilbert (2*b*) make the following significant comments on this point:

> From the evidence available it seems reasonable to postulate that any well-defined stimulus introduced consistently in connection with either right or wrong responses will tend to favor their repetition if they are right or their elimination if they are wrong, provided that the stimulus is not of such a type or strength as to introduce a distracting effect. In other words, any stimulus which is not highly distracting may act either as a "punishment" or a "reward," depending upon whether it accompanies responses which are arbitrarily designated as right or wrong. . . .
>
> In human subjects, knowledge of a "punishment" stimulus appears to mean much more than direct affective reactions to the stimulus. In the present investigation most of the subjects reported that they tried to avoid shock mainly because it signified error rather than because it was disagreeable, in spite of the fact that they all reported the shock to be decidedly uncomfortable. Their reports also indicated that they tried to avoid un-shocked blind alleys as instructed, but that they tended to forget where these alleys were in the maze and that they often failed completely to perceive that they had entered a blind alley. On the other hand, the shock which was given in the "shock" alleys announced the errors in a definite and clean-cut manner and enabled the subjects to mark the location more accurately.

If an extraneous stimulus serves to facilitate learning by way of emphasizing right or wrong responses, is it better to emphasize the right responses or the wrong responses? An answer to this question is provided by an experiment reported by Silleck and Lapha (37). A punchboard maze, containing thirty pairs of holes, was used. One hole of each pair had an electric connection with a bell which rang when the stylus was inserted. One group of subjects was instructed to place the stylus only in holes which rang the bell, while another group was instructed to place the stylus only in the holes which did not sound the bell. For one group, then, the bell meant an error, for the other group it signaled success. The mean number of trials required for an errorless performance was 11.7 for the Bell-Right response, and 15.7 for the Bell-Wrong response group. The findings are in accord with other experimental data in indicating that emphasis on right responses is more favorable for learning than emphasis on wrong responses.

When a learner must choose between two possible responses, one of which may be right and the other wrong, it seems reasonable to suppose that fewer actual errors might be made if he considers well the move he makes instead of dashing precipitously from one response to another. This view is borne out by the results of an experiment by Muenzinger and Vine (31). They used a punchboard maze which contained thirty pairs of holes. When the stylus was inserted in one of each pair, a bell rang. The subject's task was to learn to pick the hole that rang the bell. There were six groups of college students with twenty-five in each group. Group I (control) used a smooth stylus that was easily inserted into the holes of the maze. The second group (obstacle group) used a stylus that was threaded and had to be screwed into the hole. The third group (delay-after-choice) held the stylus over the hole for three seconds after the choice was made. The fourth group (delay-before-choice) paused for three seconds before inserting the stylus. The fifth group received a shock on the fingers whenever a wrong choice was made. The sixth group was shocked when a correct choice was made. As compared with the control group, which required an average of 15.9 trials and made an average of 82.1 errors, the obstacle group required only 8.6 trials and made an average of only 43.4 errors. The average results for the other groups were reported as follows: Delay-after-choice, 11.1 trials, 61.1 errors; delay-before-choice, 14.4 trials, 78 errors; shock-wrong, 17.5 trials, 81.2 errors; shock-right, 13.6 trials, 80.8 errors. The most striking feature of these results is the score for the obstacle group, which made only slightly more than half as many errors and required only slightly more than half as many trials as the control group. Why should having to screw the stylus into the hole bring fewer errors and require fewer trials for learning? Perhaps the subjects took each trial more seriously, paid stricter attention to what they were doing, and were generally more alert. Whatever the explanation, it seems to apply also to a lesser extent to delay after choice. Delay before choice did not help much. Shock on wrong choices seemed to be of no benefit, while shock on right choices showed only a slight facilitating effect. In general, it appears that factors serving to emphasize correct responses, announce errors, and make the learner more alert to cues, have a facilitating effect on learning.

Criticism. Evaluation of a student's performance is an essential part of any teacher's work. This includes the pointing out of errors and faults. Its purpose is to promote improvement. Good criticism is a valuable means of helping the learner see and correct his deficiencies. To accomplish its purpose criticism should be specific, constructive, and encouraging. For example, it will not help the child very much to tell him merely that his writing is poor and that he should do better. The specific faults in his writing should be brought to his attention with suggestions about how to overcome them. An analysis of his writing may reveal that his trouble lies chiefly in one or a few features of his writing. It may be found that particular letters are poorly formed, or that his spacing is faulty. Lack of uniformity in letter size, or poor alignment may be the principal defect. In any case, the first step in correcting faults is to locate and determine as definitely as possible what they are. In some skills it has been claimed that motion pictures of the learner's performance have proven helpful in showing what precise aspects of the operation needed correction. When the pictures are shown on the screen, they reveal all the movements made by the subject, including the useless or ineffective ones. Improvement is secured by the elimination of the waste motion revealed by the pictures. In the case of handwriting, the use of a chart such as Freeman's diagnostic chart (10) will help the teacher and the pupil to locate the precise deficiencies requiring correction.

Criticism should be constructive, not merely faultfinding. It must, to be effective, point the way to a better performance. We shall not make satisfactory progress simply by trying to inhibit the undesirable response. The best way to get rid of the undesirable response is to substitute for it the desirable one. The detection of error should serve to emphasize the need for special attention and effort on the form of response that will serve to correct the fault.

In offering criticism, the teacher should seek to avoid discouraging or antagonizing the learner. Some sensitive persons cannot take graciously even the kindest and most constructive kind of criticism. Husbands often have a hard time teaching their wives to drive a car because they are too frank in their criticisms while the wives are prone to resent the unfavorable comments on their way of handling the machine. As mature learners we should welcome the comments of a good critic. We should see in his suggestions the means of improving our skill. The teacher who flies into a rage or bursts into tears when the supervisor or principal points out some fault in his teaching simply does not have the right attitude toward the criticism. He should be grateful for a superior who is trying to help. It is far better to take criticism and profit by it than to have a superior who says nothing and then refuses reappointment because he is dissatisfied. But in dealing with little children we should be careful when criticizing their work that we do not discourage them or make them feel that they are incapable, or less capable than other children. Some children who are not doing well simply need to be told that they can do better. The teacher should show appreciation of good work, should commend the child for advances he is making. If adverse criticism is preceded by a recognition of merit, it will be easier to take, and it will be more likely to stimulate effort to improve. The effect of criticism will depend largely upon the spirit and manner in which it is given.

One possible way to avoid the negative effects of criticism is to encourage the learner to criticize his own work, to find the errors he has made, and to locate for himself, where possible, the weak points in his performance. Binet considered the ability for self-criticism to be an essential aspect of intelligence. It is well-known that it is less painful for one to speak of his own faults than to have someone else mention them. The practice of autocriticism should make for self-reliance and initiative in promoting one's own progress.

Too much guidance. While the services of a teacher in directing learning may serve to hasten it and prevent much waste effort on the part of the learners, it sometimes happens that guidance is overdone. This may occur when the teacher in her zeal to prevent all errors dictates precisely just what is to be done step by step. Too much guidance may destroy initiative of the pupil and thus deprive him of the opportunity to learn. When each step is dictated, the child may learn to perform the steps, under dictation, but fail to develop the ability to perform the whole task without aid. The end sought should be the child's ability to carry out skillfully the whole performance by himself, not the ability to follow step-by-step the teacher's directions.

The goal and improvement. Instruction, as was pointed out above, should serve not only to establish the child's goal, but should cover the ways and means for reaching the goal. A child with a goal and no knowledge of the steps necessary to achieve it must resort to trial-and-error methods of discovering how to accomplish his purpose. But emphasis on steps to the exclusion of emphasis on the goal is fully as bad as emphasis on goal with no instruction regarding the necessary steps. After a proper start has been made, practice should be aimed at the end to be achieved. Practice on difficult parts may require definite attention to the steps, but the steps should be regarded as the means for achieving the final goal. The goal gives meaning to the steps.

As an example of emphasis on steps without due regard for the final goal we cite the case of a friend, who is now past seventy years of age. When she was about ten years old, the aunt with whom she lived wanted her to learn to make a quilt. Her task, set by her aunt, was to sew together small pieces of calico cloth to make one "square" every Saturday morning. The child's goal, therefore, was not to make a quilt, but to piece a square every Saturday morning. After she had completed a square, the task for that day was done. Now at seventy years of age she still has the collection of completed squares, but she has never put them together to make a quilt. Here was emphasis on steps to the neglect of the real and ultimate goal. The goal is needed to secure the integration of the steps into the total performance.

Effective Practice

The effectiveness of practice will depend largely upon the manner in which the practice is conducted. From the great amount of work done on this subject it is possible to state a few generalizations that should be helpful to one who desires to secure the best possible returns for the time and effort expended. It should be borne in mind, however, that any generalization can be usefully applied only with such adaptations or restrictions as may be indicated by a consideration of all the requirements of the particular situation. Some of the variables which affect the applicability of the principles are age and interest of the learner, the nature of the learning task, the grade of proficiency needed, and the amount of time available for practice. The points mentioned below are those which have been found to apply in a general way to most motor-learning situations.

Conditions under which practice should be conducted. *Practice should be conducted under conditions similar to those which will attend the use of the skill, and the procedures practiced should be those in which skill is desired.* One learns what one practices. After the steps necessary for a good beginning have been taken, attention during practice should be directed toward the desired results. If it is skill in throwing a ball that is sought, the eyes should be fixed upon the target when throwing. While some useful bits of information regarding what to do in the water may be acquired on land, one must, to become a skillful swimmer, practice in the water. To be able to tackle well, the football player requires practice in real game situations. In the shop the student should have real machines and make real things. Since the fountain pen has come into general use, children should be allowed to practice writing with a fountain pen. To learn to handle a car well in traffic, the learner must have repeated opportunities to drive under traffic conditions. He will not learn this if his practice is restricted to lonely country roads. So with all skills; for best results, one should practice under conditions which resemble as closely as possible those under which the skill will be used.

Older methods of drill for students of typewriting called for a great amount of drill on nonsense syllables. Various combinations of letters were used for the purpose of having the students acquire dexterity in tapping out these combinations. It was thought that since these movements were used extensively in actual typewriting, the dexterity acquired in them would be readily transferred to the writing situation in which they would be used. No doubt some transfer does take place in such cases, but there is not full transfer of the results of practice in one situation to another type of situation. There is, therefore, a certain amount of wasted effort in such kinds of practice. Modern methods call for the student to start practicing on sentences just as soon as the keyboard is learned. It is claimed that better results are obtained by this newer form of practice. This is to be expected, since in working on sentences, the student is practicing in accord with his goal, which is to be able to type sentences skillfully.

Experimental evidence bearing on the point under consideration is found in studies made on the comparative value of different modes of practice for learning to write. Gates and Taylor (12) had one group of children trace letter forms on transparent paper placed over the letters, while another group of approximately equal ability and maturity practiced actual writing by means of a model which the children were told to copy. The tracing group improved during ten five-minute practice periods in their ability to trace letters on tissue paper, but when tested later for their ability to write with only a model as a guide, it was found that the amount of transfer from the tracing exercises to writing was negligible. The children were confused and some were wholly unable to produce a legible letter. The performance on paper with no letter underneath to trace was quite a different performance from the one they had learned. The children who had practiced copying from a model did much better in their tests. The tracing children were reported to have gained some knowledge of where to start and in what direction they were to proceed in making letters; but they could not write as well as those who practiced actual writing. Other studies have also shown that direct practice in writing is more effective in developing ability to write than practice in tracing letters by means of grooves, transparent paper, or sandpaper outlines (17).

The direction of effort in practice. *Vigorous effort properly directed is essential for best results.* Without real effort to improve there is likely to be little or no improvement. If practice is to be productive, motivation must be sustained throughout the practice periods. Complacency and satisfaction with results attained cause effort to slump. On the other hand, the learner should not be overstimulated. Anxiety is to be avoided, for it is the source of distraction detrimental to improvement. Excitement and fear are unfavorable to learning, for they dissipate energy and inhibit the effective application of effort. What is needed is an alert, eager attitude born of the desire to learn. Effort is needed, but it should be calm and steady effort, controlled and applied in the right direction. It should be intense effort, but not so intense as to disrupt precision and control of movements.

Effort should be applied in the direction of speed and accuracy, according to the requirements of proficiency. In some skills, such as dressmaking, cooking, drawing, dressing wounds and applying bandages, painting portraits, and cabinetmaking, where quality of performance is far more important than speed, the effort in practice should be primarily directed toward doing the task as well as possible. Where speed is an important factor in the skill, practice at a rapid pace is desirable. This in most cases will not be possible or advisable at first, when the appropriate movements are being selected and when the correct form is being acquired. But after these are pretty well under control, for advancement in speed, one's tempo in practice should be his best.

Where both speed and accuracy are important, as in typewriting or handwriting, to meet the requirements of expert performance, effort must be directed in such a way as to secure advancement in both. In the mirror-drawing experiment, in which subjects are instructed to work as rapidly and at the same time as accurately as possible, it has been found that some students improve more in speed while others improve more in accuracy. A comparison of the gain in speed and in accuracy for a group of fifty subjects reveals that twenty-seven gained more in accuracy, while twenty-three made greater gains in speed. Reports of the subjects indicate that self-instruction frequently operates to shift effort from speed to accuracy or the reverse. In the case of the fifty subjects mentioned, the coefficient of correlation between the gains in speed and the gains in accuracy during the fifteen trials was —.24 ±.004. This indicates a slight tendency for high gains in speed to go with relatively poor gains in accuracy and vice versa. The correlation is so low, however, that it does not warrant prediction in individual cases. While it appears that large gains in one were made frequently at the expense of gains in the other, this was not always the case.

An experiment that throws light on the relation of the speed of practice to efficiency of learning has been reported by Sharp (36). In the usual type of maze learning and in the case of the mirror-drawing experiment, the trials vary both in time and in the number of errors. In this experiment, however, a special form of maze was constructed so that the time for each trial could be kept constant and controlled. This maze was made on a circular band 9½ inches wide, around a twenty-six-inch bicycle wheel. As the wheel was rotated, the maze passed at a constant speed beneath a 5- × 8-inch opening through which the subjects worked. Data were obtained from three groups of subjects. For one group the time for a complete revolution of the maze, or one trial, was fifty seconds; for the second group, sixty seconds; and for the third group, seventy seconds. A comparison of the results from the three groups revealed that more trials were required and more errors were made as the speed per trial was increased, but for the faster speed less time was required for complete learning. The averages for the fifty-seconds group were 45.1 trials, 277.2 errors, and 37.58 minutes for total learning time. For the seventy-seconds group the averages were 39 trials, 226 errors, and 45.5 minutes.

As a stimulus for sustained effort the teacher will do well to specify the level of proficiency to be attained. If the situation warrants, an added impetus may be supplied by setting a definite time for reaching this level. The learner should be informed concerning his progress and commended for improvement. Precautions should be taken to prevent the practice from becoming monotonous. The degree of difficulty of the practice exercises should be suited to the maturity and experience of the child. The exercises should be difficult enough to provide a challenge, but not so difficult as to discourage or confuse.

Part and whole learning methods. *For complex and difficult skills use a combination of the part and whole or the progressive part method of practice.* In acquiring a skill will it be more advantageous to practice the operation as a whole or by parts? Theoretically it should be an advantage to practice by the whole method, for in so doing the various steps would be exercised in their proper sequence. In a comparatively short and simple task such as learning to slip a belt on a pulley, it would not seem reasonable to break the operation up into parts with separate practice on the parts. But in the case of complex and difficult skills the evidence indicates that some practice on parts is more efficient than a strict adherence to the whole method.

In most complex skills there are sub-skills to be acquired, which may well receive special practice. For example, in learning to be a good automobile driver, there is the matter of backing into a parking space at the curb between other parked cars, or starting on an upgrade without letting the car roll back. In learning to apply an improvised traction splint to a broken arm, the traction hitch of the hand is such an important and distinct unit of the whole that it is almost necessary to learn it separately before one can practice the whole operation. Moreover, in complex skills some parts may be easier to master than others, and in such cases it would be a waste of time to practice the easy steps as often as the hard ones. While the whole performance should be practiced as often as it is necessary to secure consolidation, it will usually be advantageous to give special practice to the more difficult parts.

Two experiments are mentioned for their bearing on this question —one in maze learning, the other in learning piano playing. Pechstein (32) used a maze divided into four sections. Different groups of subjects learned the maze by different methods. One learned it by the whole method, one learned by parts, while three learned by different forms of a combination of the part and whole methods. The method by which the maze was learned in the fewest trials, in the least time, and with fewest errors was the progressive part method. The group using this method first learned section 1. Then section 2 was learned and combined with section 1 by practice over both. Next section 3 was learned and combined with the two already mastered. Finally section 4 was mastered and the four sections were then combined.

In the experiment on piano playing, reported by Brown (5), a comparison was made of the effectiveness of the whole, part, and a combination of the whole and part methods of learning to play a musical selection. In the whole method the subjects played the whole score each time without stopping. In the part method they took one unit of the score at a time and practiced each unit an equal number of times. For the combination method the subjects first played the whole section through and then practiced an equal number of times on those measures where errors were made. In two out of three numbers the whole method was found to bring the best results. But in the case of the most difficult selection the combination method proved to be the most efficient, the whole method was second, while the part method ranked lowest in efficiency.

The distribution and length of practice periods. *For the more difficult and complex skills practice should be liberally distributed.* There are so many variables entering into the question of the most optimal length of the practice period and the optimal length of the interval between practice periods that no single specific rule applicable to all cases can be made. In general, experimental evidence indicates the superiority of distributed practice over massed practice.

Typical of the experimental findings are those from a letter-digit substitution test by Starch (40) in which four different distributions of the same total time of 120 minutes were used. The most rapid improvement was made by the use of two ten-minute periods per day. Nearly as effective was the use of one twenty-minute period each day. The results from forty-minute periods of practice once a day resulted in considerably less progress; while putting in the whole 120 minutes at one time proved very inferior to the shorter periods. This, of course, does not prove that the use of two ten-minute periods per day was the best possible arrangement for securing the most progress for the time spent in practice, even for this type of learning. It does show, as many other experiments have shown, that distributed practice is more effective for securing gains than massed practice.

Length of the practice period. Regarding the length of practice period, the evidence clearly indicates that long periods should be avoided for best results. At the same time it appears that there is a limit below which it is not profitable to reduce the length of time spent at one sitting. Pyle (33*a*), for example, compared the results from practice periods of fifteen, thirty, forty-five, and sixty minutes in a substitution experiment and found the thirty-minute period to be the most effective for gains in speed on the basis of the total time spent in practice. The fifteen-minute period was too short for best results in this task, and the forty-five minute and one-hour periods were too long. The results for the longer periods indicated very little gain after thirty minutes of practice, presumably because of fatigue in the latter part of the hour.

In a more recent experiment, Travis (45) compared the efficiency of practice periods of different lengths when the rest intervals were kept constant. The experiment was a study of improving eye-hand coordination. The apparatus used was a manual pursuit-oscillator. The learner's task was to keep a hinged stylus on a moving target. Three groups of college men served as subjects. The length of the practice periods was one minute, two minutes, and four minutes respectively for the three groups. The interpractice rest period was three minutes for all three groups. There were six practice periods; hence, the total time was six minutes for the first group, twelve minutes for the second, and twenty-four minutes for the third. The four-minute practice group made the poorest percentage score despite the fact that its total time spent in practice was four times that spent by the one-minute group. The two-minute practice group made the best score. The experimenter concluded that, since the second group which practiced a total of twelve minutes made the highest score, the second two minutes of each practice period for the third group was a waste of time and deleterious to learning (44).

It is evident that the optimal length of practice period varies with different types of learning tasks. In general, it can be said that such periods should be fairly short, but for best results, not too short. The aim should be to avoid the deleterious effects of fatigue or monotony on the one hand, and to take full advantage of momentum of effort on the other hand. In the more difficult tasks the periods of practice must be shorter than in relatively easy ones. The young and immature child will require shorter periods than an older child or adult. The periods in the early stages of learning should usually be shorter than in later stages. The reasons for these differences can be seen in the greater fatiguing effects of the more difficult tasks, the fact that younger children are more easily fatigued than older ones, and in the fact that habituated activity is less fatiguing than nonhabituated activity.

Therefore, in deciding how long one should practice at one time in order to secure the most efficient use of time, we shall have to consider the nature of the task, its difficulty, the age of the learner, and the stage of learning.

In handwriting practice, for example, ten-minute periods are long enough for beginners. Later, fifteen minutes a day will probably be sufficient, while in the upper grades the periods may be increased, but not to exceed thirty minutes. In typewriting three minutes of steady and intense effort to secure speed is considered long enough between relaxation pauses for high-school pupils. On the college level experienced teachers have found that for continuous writing at top speed the period should not extend over five minutes. As an illustration, the following case is taken from the records of one student in a college class in typewriting. Under practice periods of one-minute duration, perfect work was maintained, and for nine successive days the average speed was 47, 49, 50, 55, 53, 57, 50, 54, and 54 words per minute. Then a shift was made to two-minute periods for continuous work and the daily average per minute with no errors dropped to 39, 40, 45, and 46 words. When the five-minute period was adopted, it was no longer possible to maintain errorless work.

Length of the interval between practice periods. The avoidance of practice periods that are too long calls for periods of rest or intervals of no practice. How long should the interval between practice be? Here again a number of factors are involved. In general, it can be said, distributed practice is more effective than massed practice, but the difficulty of the task makes a difference. One investigator (6) reports that in learning mazes of different sizes massed practice (five- to ten-second intervals) was more economical than distributed practice (one-day intervals) in total errors, in small mazes, and in the early trials, but that the distributed practice was superior in the larger mazes, in the later trials, and in total time required for learning.

The superiority of distributed practice over massed practice on a Koerth pursuit rotor was demonstrated by Doré and Hilgard (7). Three groups practiced for periods of one minute but with rest periods of one, three, and eleven minutes respectively between practice. The task was to hold a hinged stylus on a small brass target mounted on the disc of a phonograph turning at the rate of one revolution per second. Within an equal number of trials the group that rested eleven minutes between trials made the greatest gain. The group resting three minutes was second best, and the group with the one-minute intervals was third. A fourth group, which worked three minutes and rested one minute, made the poorest showing of the four groups. Thus, the greater the massing of practice, the poorer were the results. In the performances of the last group there was a regular loss of score in the successive minutes of the three-minute practice periods.

Results reported by other experimenters indicate that for a given task there is an upper limit to the advantage of spreading practice out in time. It is possible to have intervals that are too long for best results. In a study of eye-hand coördination with a pursuit-oscillator, Travis (43) compared the results obtained under different interpractice intervals while the practice periods were kept constant at five minutes. Rest intervals of twenty minutes were found to produce better results than rests of five minutes, and intervals of forty-eight hours, seventy-two hours, and 120 hours. Here it appears that, for a working period of five minutes on this task, five-minute rest periods were too short for maximum gains, while intervals of forty-eight hours and over were too long. It seems that the most effective length of interval varies not only with the nature of the learning task but also with the length of the practice period. Within limits the longer practice periods call for longer rest periods. But intervals that are too long may be unfavorable.

It appears that if the learning task is comparatively easy and simple or short, it will be economical to employ massed practice. If intervals of rest are needed, they may be comparatively short. If the task is long and difficult, the practice should be spaced to avoid overcrowding and fatigue. But care should be taken not to spread out the time so long that the learner will lose interest in the work or suffer the loss of previous gains.

The time factor in learning. Several attempts have been made to explain why distributed practice is usually superior to massed practice. Some writers believe that short practice periods with frequent intervals of rest are advantageous because they avoid the deleterious effects of fatigue and boredom. But fatigue does not provide a full explanation of the advantages found in distributed practice. Spacing practice has been found superior even in cases where the practice periods were short enough to avoid fatigue; and intervals longer than necessary for recovery from fatigue have proven superior to shorter ones sufficient to rest the learner.

A theory advanced by Easley (8) holds that during practice we learn wrong responses as well as the right ones. But the wrong ones are not learned so well as the right ones because the latter are repeated more often. Since the wrong ones are not learned so well they are forgotten more rapidly during intervals of no practice. Therefore, the recurring intervals between practice sessions afford an opportunity for the progressive elimination of the wrong responses. One drawback to this theory is the fact that sometimes a wrong response is made more often than the right, particularly in the early stages when distribution of practice appears to be of greatest value.

Another theory maintains that the advantage of distributed practice is due to growth that takes place during the interval between practice. According to Snoddy (38) there are two distinct processes of growth involved in learning. One, called *primary growth,* is said to be a positive function of both repetition and the interpolated time intervals, while the other, called *secondary growth,* is the result alone of the stimulation afforded by practice. Primary growth comes early in the practice series. It is a setting or stabilizing process that establishes a base upon which the effectiveness of later practice depends. Short periods of practice stimulate primary growth, which continues through the interpractice interval.

Rhythm. The development of motor skills involves both spatial and temporal coördination of movements. Rhythm is an aid in establishing temporal coördination. The playing of music with lively rhythm will help to speed up the slow worker. Since it operates to reduce tensions in muscles not directly used in the task being practiced, rhythm tends to lessen the fatigue effects of practice. It is desirable to have children practice their writing exercises in rhythm. Music may be used to set the pattern of rhythm. The rhythm of music, counting, or tapping is used to advantage in pacing the strokes for typewriting drills, in directing calisthenics, for establishing the proper timing of movements needed for giving artificial respiration, and to promote the gracefulness of dancing.

But to secure the advantages of rhythm one must know at what stages to use it. A reasonable familiarity with the task, the ability to make the various movements, and proper form are essential prerequisites to the use of rhythm drills. A young teacher who had been working in her first position only a few weeks complained that she could not keep her pupils together in group drills in typewriting because they had to stop and look for the keys. Students will not be able to type rhythmically until they have learned the position of the keys. Children will be able to write rhythmically only when it is no longer necessary for them to stop to think of the various movements required to form the letters or of the correct position of their fingers and hands. According to Freeman (11), writing becomes rhythmical for most children at the age of nine or ten. He suggests that this is the age when writing drills requiring ryhthm may be suitably given.

Moreover, group drills in which rhythm is used will not in the later stages of practice be suitable for developing maximum speed. There will be individual differences in capacity for speed, which will render any pace unsuitable for all members of the group. If the tempo is suited to the average, those who could go faster will be held back while certain slow ones will not be able to keep up or will work under too great a strain in doing so. In order to attain the greatest possible speed the individual must practice at his own best speed.

Individual Differences in Motor Learning

In any large group of learners we shall find extensive differences in any aspect of the performance at any stage of learning. As an example we take the case of a group of 133 subjects in our mirror-drawing experiment. The range in time for the first trial was from 538 seconds for the slowest member of the group to thirty-nine seconds for the fastest. The mean time for the group in the first trial was 178 seconds. For the fifteenth trial the range for time scores was from 151 seconds to fifteen seconds, with a mean score of fifty-two seconds for the group. For the first trial the number of the errors ranged from 155 to five, with a mean error score of fifty-four, while for the fifteenth trial the error range was from ninety-two to zero, with twenty-two as the mean. The scores of several students were better for time on the first trial than the average of the group on the fifteenth trial, and this was also true for errors. Some made more errors on their last trial than the average for the group on the first trial. The gains varied from less than ten per cent to more than eighty per cent.

Such variations among individual members of a group will be found in any learning situation. They are due to the influence of many different factors, including differences in attitudes, interest, desire to improve, conscientiousness, physical condition, previous experience, self-instruction, abilities, temperament, and differences in the experimental situation.

The age factor. In general, the ability to acquire the more complex motor skills improves with age up to maturity. The young child is limited by lack of maturation. As he grows older his coördination, control, and steadiness of movement improve, he becomes more resistant to fatigue, and is more capable of sustained attention and interest. In comparison with a five-year-old, an average child of seven years of age can run faster, throw a ball farther and more accurately, kick harder, and jump farther (23). A young child's reaction time is considerably slower than an adolescent's or a college student's (13).

When children of different ages are compared with each other, or with adults, in ability to master an experimental task in motor learning, the older individuals are found almost invariably to be superior in rate of learning or in the degree of skill attained under similar conditions of practice. For example, Gould and Perrin (14) found a group of college students to be superior in maze learning to a group of children whose average age was 11.6 years. Likewise, high-school pupils surpass elementary-school children in maze learning. In an experiment with a pursuitmeter in which the problem was to keep a stylus on a moving electrode in order to keep the machine running, three age groups between seven and seventeen years were compared by Langhorne (25). For both boys and girls the rate and limit of improvement was higher for the older groups. Willoughby (49) found that the ability to make a good score in the digit-symbol substitution test improved sharply from childhood to about the age of twenty-two and then declined gradually toward old age.

The adult is superior in this type of learning because of his greater physical maturity, his wider range of experience, and his greater ability to detect errors and sustain attention. In performances requiring a high degree of suppleness, such as acrobatic feats, the greater plasticity of a child may be an advantage. Acquired habits of the adult may operate as an interference, as in the case of learning the pronunciation of a foreign language. In such a case it appears that it is an advantage to begin young. But this is not sufficient grounds for placing the teaching of foreign languages in the elementary grades. The high-school or college student can learn a language so much faster because of his greater understanding and maturity that the small advantage gained for pronunciation habits would be secured at too great a sacrifice of time, effort, and other learning. For a skill like dancing, it is probably best to begin while one is still young. But in typewriting we cannot expect a child of ten years to improve as fast with the same amount of practice as a student of sixteen or eighteen years of age (9).

Previous training. Another important source of individual differences in motor learning is to be found in differences in previous training. Telford and Spangler (41) have demonstrated the superiority of pianists over non-pianists in rate of tapping in six different tapping exercises. This is attributed to the pianistic training, which apparently had developed speed, accuracy, and steadiness of arm movement. Without going into the question of transfer of training at this point, it can be safely assumed that when approaching a new task the learner brings with him the results of a great amount of previous training. This, as mentioned in the preceding paragraph, may sometimes interfere with the new task, but in many cases the previous practice will have developed abilities that can be immediately applied to the new task. Training in art, for example, has been found by experiment to transfer to the mirror-drawing situation. The effects in this case were most clearly demonstrated in the early stages of learning (28).

The effect of previous training on persistence in a learning task was studied experimentally by Morgan and Lannert (29). The subjects were two groups of children paired for age, sex, and intelligence. Each group was tested for performance on a maze problem that had no solution. Prior to this test the experimental group learned three mazes in order of difficulty. The control group was given no training with mazes before attempting the unsolvable task. It was found that the children who had preliminary maze training worked almost twice as long as the control group at the maze that could not be solved, and the quality of their work was considered to be much better. Thus, the expectation of success based on previous success appears to be a potent factor for effort and achievement.

Motor learning and sex. There is no clear-cut evidence of significant differences between the sexes in motor-learning ability. Some reports favor men while others indicate a slight superiority of women. Pyle (33*b*) found girls superior to boys in card-sorting experiments. It is commonly supposed that motor activities involving great endurance or muscular strength can be handled better by men, while women are likely to excel in skills requiring close coördination of small muscles and strict attention to detail. It is doubtful, however, whether there are any innate differences other than possibly that of muscular strength. Watchmaking, surgery, and violin playing are examples of skills requiring delicate coördination of small muscles and close attention to detail, and in these it cannot be said that women surpass men. Moreover, there are comparatively few skills depending so much upon brawn that women may not become as competent in them as men. The division of motor skills between the sexes is primarily a matter of social tradition and training (22).

Motor learning and intelligence. The degree of intelligence required for successful motor learning depends upon the nature of the skill to be acquired. Some skills require a high degree of intelligence, while for others a comparatively low level of intelligence is sufficient. If the activity is complex and if it requires insight, understanding, and judgment to direct its course, as in the case of a surgical operation, intelligence of a high order is essential. If only perception is needed to direct the course of the performance as in scrubbing floors or washing a car, little intelligence is needed.

During the first World War the Army Alpha Intelligence Test was given to many thousands of recruits. The range of scores was divided into seven sections as follows: A meant high; B fairly high; C and C+ average; C— low; and D, D—, and E very low. A study was made of the relation of the men's occupational status in civil life to their standings in this rating of their intelligence. The professions fell for the most part in groups A and B. This included physicians, civil and mechanical engineers, draughtsmen, business executives, and teachers. In the C+ group were found stenographers, telegraphers, band musicians, photographers, electricians, and workers in other high-grade skills. In group C came machinists, blacksmiths, plumbers, mechanics, carpenters, printers, butchers, and tailors. In the lower groups, C— and D, were fishermen, cooks, barbers, firemen, and day laborers. Since many other factors besides intelligence enter into the determination of one's vocation, it is not surprising to find a considerable amount of overlapping of these occupations. A number of laborers, for example, rated A. Yet these findings tend to confirm the general conviction that there are important differences in the mental ability essential for success in the various occupational skills.

In a study of motor learning in relation to intelligence, Johnson (24) used as subjects three groups made up of inmates of the New York State Reformatory for Women. These three groups represented the upper mental level for the inmates, the medium reformatory type, and feeble-minded class. The subjects were studied for their ability to acquire skill in throwing darts at a target. The most intelligent made the highest average score, the medium group was second best, and the low or feeble-minded group made the poorest average score. This investigator states, "While the data indicate the effectiveness of superior intelligence in the acquisition of skill in the target test, there is evidence of great capacity to improve in the upper-grade mental defective."

For a college freshman class of 65 students in typewriting the writer found a coefficient of correlation of .28 ± .07 between the score on the Otis Self-Administering Test of Mental Ability and semester grades in the course. This is a low correlation, but it indicates a slight tendency for the students who had the higher scores in the intelligence test to get the better grades.

In training feeble-minded individuals in manual tasks, it has been found necessary to fit the task to the level of intelligence. A boy with a mental age of seven can sew a broom but it takes a mental age of nine or ten to build up the shoulders of a broom. Girls with a mental age of six can learn to crochet, but high-grade fancy embroidery calls for a mental age of from nine to twelve. An imbecile can tear off the soles from old shoes or pick apples which are to be used for cider, but he cannot operate a burnishing machine nor pick apples for packing without bruising them. The higher grade idiot can be trained to pick up stones and do a few very simple tasks under supervision, but he cannot wash dishes. For dishwashing the minimum I.Q. of approximately 26 to 30 is found in the low-grade imbeciles. A man with a mental age of seven can paint a barn under supervision, but he cannot estimate costs or mix paints. An imbecile can learn to milk a cow, but the minimum I.Q. for general farm work is about 65 or 70. In general, it has been found that the more complex the task the higher is the minimum mental age needed to master it.

Tests of motor ability. It seems reasonable to suppose that one who has a quick reaction time, one who can maintain good speed in a series of movements, one who has good motor coördination and good motor control will be able to make better progress and reach a higher level of proficiency in skills for which these abilities are essential than one less gifted in these respects. Several tests of these motor abilities have been in use for a long time in psychological laboratories. These with other tests have proven useful in gaining a clinical picture of an individual, and in some cases their use is valuable in guidance counseling.

Among the simpler tests of motor ability are those which measure rate of tapping, accuracy of aiming, steadiness of the hand, and eye-hand coördination. In one form of the tapping test the subject taps with a stylus on a metal surface as rapidly as he can for a period of thirty seconds. The score is the number of taps in this standard interval. The number is recorded automatically by an electric counter. In one test of steadiness of the arm and hand the subject is required to insert a stylus into a small hole in a metal plate and hold it there for fifteen seconds without touching the side of the hole. There are nine holes of different sizes. The number of the smallest hole which the subject manages successfully is his score. Precision of movement is measured by having the subject strike at a target with a pencil. The score is the distance in millimeters between the point aimed at and the point actually struck. In the test the average is taken for a number of attempts, usually thirty. For testing eye-hand coördination, a tracing board is commonly used. Here the subject draws the point of a stylus toward himself through a groove that is narrower at the near end. He is instructed to proceed as far as he can without touching either one of the sides. Many variations of these tests are used. In a test of hand and finger dexterity the subject is required to place three pins in each of 100 holes drilled in a board. In a similar test tweezers are used to handle the pins.

In a number of cases a battery of tests has been set up for the purpose of determining an individual's chances of success in a given skill or vocation. Many have been developed in the field of physical education (4). Others have been devised to predict success in industrial occupations (16). Sometimes tests of interests, perceptual alertness, judgment, and manipulative ability are included in the battery in an attempt to determine mechanical, musical, or artistic aptitudes (3, 15, 20, 46, 48). Some of these tests have not been very reliable or valid owing to emphasis on factors bearing little relation to success. For example, some of the earlier tests for ability in athletic skills placed too much emphasis on strength and size, whereas neuromuscular ability, as indicated by motor performance, appears to be more significant. Also, a test measuring an ability subject to improvement by practice, such as card sorting, that does not take into consideration differences in previous experience cannot have high predictive value. There are now many good tests of this type that have demonstrated their value and practical usefulness for school and industry.

A good example of the use of a motor test in educational research is a recent experimental study by Rowley (35). Her problem was to find out whether or not slow writers in grades IV, V, and VI were inferior in motor coördination to the fast writers. On the basis of suitable speed tests of handwriting, two groups of children were selected, one made up of the slowest, and the other of the fastest writers. Each group included twenty-five children. The members of the two groups were paired for sex, C.A., M.A., and I.Q. These children then were given the tapping test for the right and left hands. By means of special apparatus, a test was made to determine the speed for making short vertical finger movements similar to those used in writing. Tests were also made for speed in making similar movements with the arm. The scores of the slow writers on these tests were compared with the scores made by the fast writers. There was no significant difference between the scores of these two groups on any of the tests. It was concluded that the difference between these slow writers and these fast writers was due mainly to training factors, and not to a difference in native endowment with respect to capacity for speed or motor coördination. The findings indicated the possibility of successful remedial instruction for improving the speed of slow writers.

Summary of the Chapter

Motor skills play a large part in our lives. They are essential to many vocations and recreational activities. A number of motor skills are developed in the school. Motor learning has been studied extensively in experiments with mazes and pursuitmeters, and on mirror drawing and card sorting.

The development of motor skills involves the modification of tendencies governing action. In general, it is a process of reducing purposive action to sensorimotor action. In this process the task drops out and the control of action is taken over by habit. Other changes include the decline of perception, the elimination of irrelevant responses, a decrease in tensions and unpleasant feelings, and a stabilizing and consolidation of the total performance. There is also an increase in the speed and accuracy of the performance, and it is carried out with less fatigue.

For economy and efficiency in motor learning the learner must have a goal; he must know what to do and have a desire to learn. Instruction in what to do and how to do it saves time and effort, and prevents the waste and inefficiency of trial-and-error learning. Demonstrations are helpful if properly given. They do not provide the skill, but they show the learner what to do to acquire it. As a rule, directions should be positive, and they should cover matters of good form for the particular skill. The learner should have good tools or instruments with which to work.

In practice or drills the teacher should be on the alert to check errors. If a learner cannot discover his own faults, they must be pointed out to him. Criticism and evaluation of the pupil's work should be constructive and friendly. Too much guidance with respect to details may stifle initiative. The child must always have a goal but in most cases it will be necessary to instruct him in the steps necessary to reach his goal.

Practice is essential for acquiring motor skills. To be most effective it should be conducted under conditions like those attending the use of the skill. Effort should be applied toward speed and accuracy according to the requirements for proficiency. As a rule, a combination of the part and whole methods of practice brings best results. Distributed practice is usually more effective for the time spent than massed practice. However, the best distribution varies for different tasks. For young children, for difficult tasks, and in the early stages of learning, short periods of practice are desirable. Longer periods may be used for older learners, for easy tasks, and in the later stages of learning. Rhythm is often helpful in promoting coördination of movements.

Individuals differ widely in motor learning. Younger children, as a rule, are inferior to older children and adults. Differences in motivation and in previous training are responsible for many differences in performance and progress. The sexes do not differ appreciably in ability to acquire motor skills. In general, the more complex the task, the greater is the degree of intelligence needed to perform it skillfully.

Many tests of motor abilities have been devised and they may be used to determine whether an individual has the necessary speed, coördination, and motor control for success in learning various skills.

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CHAPTER XII

THE DEVELOPMENT OF PERCEPTION

A large part of our learning is accomplished through perception. In the first place, we learn directly about things by observing them. In addition to this, perception often plays an important part in other learning activities. It fuses with action. It is a frequent source of the task. It is essential to learning by imitation. It furnishes the experiences that promote understanding and augment reflective thinking. Without it we could have no memories, no imagination. It is the initial step in most of our emotions. Through perception we learn, and without perception there could be no learning except possibly that of the most primitive and meager sort. But what is probably not so fully realized is the fact that we also learn to perceive. The perceptive functions themselves have a developmental history of trial, elimination, inclusion, and consolidation which goes back to the individual's birth and possibly even into his racial past. Though the contributions of racial development to perception may be important, our concern here is only with the increase in functional efficacy accomplished during the life history of the individual through his own experiences. The present chapter is devoted to the development and modification of the tendencies and predispositions that initiate and govern the perceptive functions and the resulting changes in these functions.

THE GENERAL NATURE OF THE PERCEPTIVE FUNCTIONS

Perception is a fundamental psychological activity. It is something the individual does. It is not, as we consider it, a faculty of the mind, nor merely a cluster of sensations. Sometimes it is described as a process of getting knowledge of the physical world, or as a means of making adjustments to the environment in which we operate. Knowledge and adjustments are important outcomes of perception, but to understand the role of learning in the development of this function it is necessary to consider the nature of the process itself. In perception we apprehend objects or events. When we perceive, we translate impressions made upon our senses by the stimuli from our environment into awareness of objects or events. Moreover, the temporal reference is to the present, for the objects and events of which we become aware are regarded in perception as present and as going on. This activity of perceiving is such a universal and intimate feature of our mental life that it is often difficult to realize that objects of the physical world do not merely present themselves and that we do anything more than open our minds to receive them as they really are. It is easy to overlook the fact that we construct our world of things and events out of our sensory processes and that physical objects as we know them through sight, sound, taste, smell, and touch are the products of our own perceptions.

Essential features of perception. *1. Sensory experience.* All perceptions are characterized by the presence of sensory experience. This includes the various qualities of experience derived from the stimulation of the sense receptors by the appropriate physical stimuli. Visual sensory experience consists of many thousands of different visual qualities. These include all shades of grays and the colors—reds, yellows, greens, blues, and their intermediates in all degrees of saturation from the richest colors to grays and in all tints and shades from lightest to darkest. In hearing we have tones and the various kinds of noises. The tones vary in pitch, and a good ear can distinguish approximately 11,000 differences in the range from the lowest to highest. Sweet, salty, sour, and bitter are the primary taste qualities. In the olfactory group are a great variety of odors. The sense of smell provides the odors of flowers, fruits, spices, decayed flesh, burnt cloth, and many others. From the receptors in the skin and in the internal organs we get such qualities of experience as sensory pressure, pain, warmth, and cold; and from the proprioceptors in the muscles we get the strains and pressures of kinesthetic experience. These widely differing qualities of sensory experience depend upon the organs of sense and upon the nervous system. They are the basis of our knowledge of the world about us. Without them there would be no awareness of anything.

2. *Meaning.* The mere experience of a particular color, sound, taste, smell, or touch appears without learning. We do not have to learn in order to sense the color blue, the rumbling sound of thunder, the odor of violets, a salty taste, or a pain. But we do have to learn what the color is a color of. We have to learn to identify one noise as that of thunder, another as the roar of an airplane, and another as the report of a pistol. We learn to perceive objects, but we have sensory experience directly as the result of the impact of environmental forces upon the bodily mechanisms of perception.

When the qualities of conscious experience refer to an object or event in the physical world, they are said to have *meaning.* All perceiving involves the factor of meaning. When we see a chair, a tree, or a house, we perceive the objective fact. The thing-out-there is the meaning that the pattern of colors and lights has for us. The relation between sensory experience and meaning is mainly the product of learning.

Meaning and the components of sensory experience are two distinct aspects of perception, admitting of separate consideration. A particular set of sensory components may take on new meaning. Note, for example, the forms shown in figure 27. We see at first four squares, one with a dot in the center, the second divided into halves by a vertical line, the third divided into two equal triangles by a diagonal line, and the fourth divided into halves by a horizontal line. If we now find that these are the symbols of a code in which the first square represents the letter *B,* the second *O,* the third *A,* and the fourth the letter *T,* the four squares take on the meaning of *boat,* which they did not have for us at first. The weird sounds made by a loon in the night on a lonely lake may be, to one who has never heard them before, the alarming cry of a person in distress or the whooping and wild laughter of an intoxicated bathing party. But after he has learned the true source of this queer complex of sounds, it is the delightful and unique call of a beautiful bird that flies, swims on the water, dives, and swims long distances under the water.

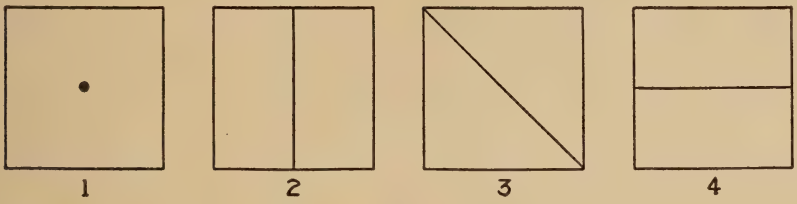

Fig. 27. When you learn that 1 represents the letter *B,* 2 the letter *O,* 3 the letter *A,* and 4 the letter *T,* the group of four squares means the word *boat.*

Also, meaning may be stripped from sensory experiences. This sometimes occurs under repetition. Take almost any word and repeat it aloud rapidly for two minutes. By the end of that time the vocal sounds will probably have little meaning for you or anyone listening to you. Moreover, there are times when the meaning lags behind the experience, as when we hear a sound which at first has little or no meaning for us, and then suddenly we realize that it is the sound of a distant steamboat whistle. Again, the same meaning may attach to different sensory items, and different meanings may be carried by the same items of experience. The meaning of *five* may be presented visually by five single marks, the symbol 5 or V, or by five fingers held up. It could be indicated in auditory experience, as well, by the sound of the spoken word "five," or by five taps. The same meaning could be attached to taste, smell, or touch qualities. The vocal sound "tu" may mean "two," "to," or "too," according to context.

3. Patterning of the sensory qualities. Perceptual meaning depends upon the patterning of the sensory field. The matter of organization of the sensory field has already been discussed in chapter VIII. There it was pointed out that in perception the sensory field is primarily organized on the basis of figure and ground. Certain sensory components are relatively closely knit together and marked off by more or less definite boundary lines from surroundings, which constitute the ground. These components make up the figure and usually represent what is perceived. As the figure-ground relations change, the meaning changes; that is to say, as the figure changes, the object perceived changes. For example, we look at a puzzle picture and see a tree. The meaning that the particular pattern of grays, greens, and browns have for us is a *tree*. But as we gaze at this array of printed colors, suddenly they seem to form themselves into a new configuration and what for us were boughs and leaves of a tree now are a number of human figures. The reorganization was a change within us; it was not a change in the picture itself.

There are various forms of patterning involved in perceptual experience according to the sensory modalities involved. For example, the colors and grays in visual perception are arranged in mosaic-like spatial patterns, spread out in two-dimensional array. Tones and noises fuse and blend. Fusions of tones give us musical chords. These may also be ligated in temporal sequence as in melodies. Tastes and smells blend. Tactual impressions sometimes blend and sometimes occur in spatial patterns. These various patterns are frequently linked together to make up larger temporal patterns. In observing a motion picture, for example, the sequence of changes in patterning is of prime importance in our perception of the various forms of movement.

4. Sensory discrimination. In order to have patterns of sensory qualities, the individual must be capable of sensory discrimination. To have visual patterns the individual must be sensitive to different colors and grays. For tonal patterns such as we find in music, there must be the ability to discriminate tonal differences. The same is true for all the senses. Thus, sensory discrimination is also an essential for perception. The efficacy of perception depends in no small degree upon the range of distinguishable sensory elements. Certain color-blind persons, for example, are not capable of sensing the difference between stimuli that yield for normal vision the colors red and green, and they find it impossible to distinguish between red and green objects that are alike except for the color. Things that look exactly alike cannot be distinguished in visual perception. If a distinction is made, other senses are used. If a person's hearing were so dull that he could not distinguish more than ten tonal pitch differences, his perception of music would lack most of the fine variations and harmonies we normally know as music. If one could hear only one quality of sound, he could distinguish sound objects only on the basis of variations in intensity and duration of that sound. Thus, the greater the range of noticeable differences in the qualities of sensory experiences, the greater will be the possibilities of making fine distinctions in perception.

Can sensory discrimination be improved? If this question is interpreted as referring to perception, the answer is "Yes." If we interpret it to mean the improvement of the capacity for sensing, or sensory acuity, the answer is "No." We can train our perception. But if a person is dull in hearing, training will not improve that hearing capacity. Color blindness cannot be cured by practice in looking at colors. Perhaps in some instances certain exercises may help to remove certain sensory defects, but these do not come under the term *training,* as used here. The sensory mechanisms are limited regarding the variety of experimental qualities they can provide. Training does not change this capacity, but training may greatly improve the use of one's sensory capacity in distinguishing small differences. Children improve in their ability to distinguish between letter patterns in learning to read. In experiments on conditioning, animals and human subjects have learned under training to discriminate between similar stimuli so as to respond to one and not to the other, when before training they reacted to both.

The various objects of perception. The objects of perception are not all concrete and particular space-filling, material objects. We perceive sound objects, for example—music, melody, and rhythm. We apprehend events, work, or study. We note the material of which a garment or a piece of furniture is made. We sometimes perceive an object not merely for itself alone, but as a representative of the class to which it belongs, the meaningful reference in such cases being not to the particular thing at which we are looking but to the whole class. Thus, the thing is perceived as a sort of generalized object. Such would be the case when a child goes to the zoo and for the first time sees a lion. His perceptual meaning might be expressed in words such as, "So that is what lions look like." Or we may see a copy of a new novel and reflect that *it* is the author's latest creation.

Then there are perceptions through which we realize the moods, emotions, and motives of other persons—valuable perceptions for getting along socially. We perceive complacency, indifference, happiness, and sorrow in our friends. There are also esthetic perceptions, which afford the realization of beauty and the enjoyment of good humor. Relationships are often important objects of perception. We perceive the height of a building, the width of a river, the distance to school. We observe that one event invariably precedes another, or that John is taller than Henry. We note the passing of time and realize that some events transpire quickly, while others run on and on. We observe that the apples are ripe, that the coffee needs sugar, that the potatoes are cooked, that the room is too warm, that the ring is made of brass, or that the man is old.

Moreover, we perceive objects not for what they are themselves but for what they stand. When an object stands for or represents some other thing or fact, it is a symbol. The meaning of a symbol is *symbolic meaning*. A sign is a symbol because it signifies a fact beyond itself. Thus, the arrow on a trail tells us which path to take. The red flag is perceived as more than simply a red flag: It indicates danger, and the need for precaution. Printed and spoken words, numbers, and code signals are symbols, and for the initiated they bear a meaning of a higher order than that of vocal sounds or of printed forms. Symbolic perceptions play an important rôle in problem-solving thinking. In terms of the outcomes, such perceptions are not always distinguishable from actual problem solving. The essential distinction lies in the presence or absence of a problem to be solved. Upon merely seeing the gates down at a railroad crossing you would probably realize at once that a train is coming—symbolic perception. If, however, you wanted to know whether or not a train was approaching and turned to look at the gates to see whether they were down as a means of settling the question in your mind, you would be solving a problem. The outcome in either case would be the realization that the train is coming.

Modifications of Perception through Activities

Our perceptions do not come ready-made. Neither are they fixed and immutable processes. They grow, and in growing they change. They are enriched in detail and become more definite, refined, and specific. Like action, under repetition they tend toward economy of performance by the elimination of superfluous adjuncts. These modifications, like all learning, are the results of activities. Various functions leave their traces in the form of trends, predispositions, and tendencies that control the course of our perceptions and determine the nature of their outcomes (11). It is customary to refer in a general way to these traces of antecedent functions as the influence of past experiences. The principal modifications are alterations in the sensory patterns, changes of meaning, reduction of cues, and greater adroitness in detecting small differences.

Changes in sensory patterns. Whether or not there is some innate predisposition which causes a newborn babe to see unit forms against a background without learning, as some claim he does (6), there is no doubt that the way older individuals organize their sensory field is influenced by tendencies and predispositions resulting from their earlier activities. The establishment of a particular pattern inclines the observer toward such an organization of his perceptual field on subsequent occasions. Once we have discovered the hidden figures of a puzzle picture, these figures are usually very persistent and compelling in later perceptions of the picture.

A simple experiment frequently used in the laboratory to demonstrate the development of perception reveals various changes in the sensory patterns that are fairly typical. A dozen small cardboard boxes are used. These boxes are alike in appearance, and each one contains some small and familiar object, such as a penny, nail, or paper clip. The subject is asked to lift and shake each box and tell, if he can, what is in it. In naming the object he reports the meaning he attaches to the sounds and tactual pressures. He is also asked to report on his attention, sensory experience, and mental imagery. After this he is shown the object or told what it is. This procedure is followed through with each of the boxes and then the whole series is repeated as many times as is needed for the subject to learn to identify all the objects correctly from the sounds and tactual impressions. The boxes are presented in a different order in each trial to prevent serial learning of the names of the objects. The most easily observed change is in the meaning that the sounds and pressures have for the subject; but careful observation reveals a number of coincident changes in the experiential components and their integration.

In the process of learning in this experiment we have the elimination from the foreground of those sensory elements that are of no value in identifying the object or that do not contribute to the subject's ability to distinguish between objects. This is the case for those sounds and pressures that are so similar for the various objects that no difference can be detected. Also new elements are added as learning goes on. Some peculiar quality of sound, overlooked in the early trials, assumes a place of prominence in the field because it is just what enables the subject to distinguish a particular object. It might be a slight scratching noise or the distinctive pitch of a sound, which emerges to take an important place in the new configuration. That which is unique about the sounds and pressures in each case becomes the significant feature for correctly identifying the object in auditory-tactual perception. These unique features are sooner or later selected, isolated, and integrated into a new and unified pattern that means *penny, nail, paper clip,* and so on, through the list.

In these configurations auditory qualities, which at first are discrete or separate, become fused and temporally ligated parts of the new whole. Pressures and noises, which in the early trials are unrelated, become closely incorporated into new unit patterns when their particular combination becomes important as an identifying sign. For example, a swish, a clack, and light pressure may become unified to mean *a paper clip;* and a scrape, thud, and heavy pressure become welded together to mean *a flat square piece of lead.* In perception the sensory components are frequently supplemented by visual or by other forms of mental imagery derived from previous experiences. In this experiment the imaginal supplements also are observed to undergo change. Some appearing in the early trials drop out as their inappropriateness is discovered, and new ones enter after the subject sees or is told during the course of learning what each box contains.

In another experiment (12) a series of twelve simple irregular figures formed by dotted lines were first shown to a group of subjects. Later these figures were presented again but as parts of larger and more complex figures, the larger figures thus "masking" those of the original series. To a control group the larger figures were presented without the previous showing of the simple figures. It was found that the experimental group tended to see readily the masked figures as units in their respective complexes because they had previously observed these figures in isolation. The control group saw the masked figures much less frequently because no predisposition had been established for them in previous experience, as in the case of the experimental group. The latter saw the masked figures as units in the larger figures twenty times more often than did the control subjects. It is evident that what we see depends upon the organization of our visual field, and this organization is greatly influenced by previous experiences.

Changes in meaning. As experiences increase, perceptual meanings change, tending, as a rule, to become more definite and more effective as a means of adjustment. An acquaintance walking along a dimly lighted street on a rainy night came to a crossing where the pavement was broken. He saw a dull, irregular patch of gray which he took to be a piece of the broken cement pavement. It appeared high and dry, so he proceeded to step on it. To his consternation his foot splashed into a puddle of muddy water. The experience of hearing the splash and feeling his foot slipping into the mud quickly changed the meaning of his visual pattern from *cement* to *mud puddle.*

In some cases the pattern of learning involved in the development of perceptual meaning is similar to that of conditioning. A child who is learning to read is shown the word *house.* He does not know what it means, but the teacher says, "House." He knows the meaning of the spoken word. By the association of the spoken word with the printed symbol the latter takes on the meaning of the former. A person may get the meaning of coolness when he sees the shade of a tree. This is because he has felt the coolness of the shade on former occasions in connection with seeing it. As one handles an apple, he sees its color and form, feels its smooth waxy surface, and if he eats it, he gets the odor and taste of the apple. Later the visual stimulus-pattern alone sets off a perception, the meaning of which encompasses all of these features. The individual gets directly from the stimuli only a pattern of color, but he apprehends an apple; and because of all the various past experiences with apples he sees an edible fruit with a characteristic texture, odor, taste, and smooth surface. He does not think of each of these qualities of the apple in separate thoughts, but they are included in his meaning, for he has learned that an apple is that kind of thing, and the visual stimuli now set off the perception of an apple, not merely of a disc of color.

Cue reduction in perception. A special case of the change of meaning in perception is cue reduction, mentioned in chapter II. From the name it might seem to be more appropriate to describe this as a change in the perceptual pattern without change in the meaning. There is a change in pattern because certain parts of it are dropped out, and the meaning carried by the original pattern is now attached to the remaining portion. On the other hand, we have a change of the meaning borne by the part which remains. You hear a voice over the telephone and do not recognize the person speaking. He must tell you his name. Later you get well acquainted with this person. He calls you on the phone, and you recognize him by his voice at once. The quality of this particular voice is now sufficient for the apprehension of the person calling. It has taken on a meaning which at first it did not have.

In cue reduction a part stands for the whole, or at least renders the same service for perception as it rendered earlier only in conjunction with other stimuli. Thus, the sight of a human foot means a whole person is present, a particular noise means an airplane overhead, and a scorchy odor that the potatoes have boiled dry. The role of past experiences with a larger range of stimuli is recognizable in these cases and in countless others which the reader may readily bring to mind.

Cues in visual space perception. The stimuli from objects of our environment make impressions upon our sense organs, and the unique features of the various impressions become significant cues for apprehending and distinguishing the various objects. A good example of this principle is found in the visual perception of distance and the tridimensionality of objects. The mosaic of colors and grays resulting from light patterns on the retina is not of itself sufficient to enable us to see an object as solid or one object as farther away than another. Persons who are born blind and who later in life have been given sight by an operation have found it necessary to learn to judge distances in visual perception. The visual stimulus-pattern provides cues that make this possible. But we must learn to use them. The learning activities involved are believed to be mainly touching, handling, and exploratory movements of various sorts.

Of primary importance in our perception of the three-dimensional nature of objects is the difference between the stimulus-patterns received by the two eyes. If an object is not too large and not too far away, we see more of its left side with the left eye and more of the right side with the right eye. Therefore, the two ocular impressions are not identical, and the difference becomes a cue for the apprehension of the spatial character of the object. We learn to see the object as solid or extending from us in space because normally only three-dimensional objects could yield disparate impressions in binocular vision. A perfectly flat surface would yield like impressions. Hence, we learn to translate retinal disparity into depth.

The way this operates may be seen in the following example. If one holds up his two index fingers before his eyes, one about eighteen inches from the nose, and the other at a distance of about twelve inches and about one inch to the left of the line from the nose to the farther finger, and looks at them first with the right eye and then with the left, he discovers that the fingers appear closer together for the left eye than for the right. This is because the retinal images of the two fingers are closer together in the left eye, owing to the nature of the eyes, to the actual position of the fingers, and to the way the light travels from the fingers to the retinas. Now if we reproduce artificially this stimulus-pattern on the retinas by means of a stereoscope and a stereograph with a pair of vertical lines on each side, one pair for the left eye to see and the other pair for the right eye, but have the lines on the left side closer together, we see not four lines but two, and one of them is seen farther off in space. Looking at the stereogram without the stereoscope we see four lines, two on each side, but all on the same surface and equidistant from the eyes. The stereoscope reproduces the retinal conditions normally produced by two vertical objects when one is farther away. The stimuli, the receptors, and the nervous system provide an experience-pattern corresponding to conditions in the external situation, and we learn to use this experience-pattern as a sign in apprehending objects and events.

Other signs or clues used in visual depth perception are available in monocular vision and give the meaning of relative distance of objects in a picture, where the light is reflected from a flat surface. These are: size, distinctness of contour, convergence of parallel lines, height in the visual field, covering, and distribution of light and shade. An object of a given size makes a smaller impression on the retina the farther away it is. Distant objects usually make less distinct impressions than near objects. Parallel lines appear to converge in the distance for the same reason that a far object appears smaller than a near one. Distant objects usually appear higher in the visual field than near objects because of our own upright position. Near objects sometimes cover or shut off in part our view of the more distant ones. Uneven surfaces produce shadows. These physical conditions produce their corresponding effects in our perceptual field; and by learning their significance, we visually perceive the relative farness or nearness of the objects about us.

Auditory perception of distance and direction. Sound stimuli grow weaker the farther they travel from their source. If the sound waves come from points in the median vertical plane between the two ears, they will strike the ears with equal intensities, but if they come from one side, the intensity will be slightly greater for the nearer ear. Also sound waves from the left side will strike the ear on that side a fraction of a second sooner than the right ear, the reverse being true for sounds from the right side. The individual learns to use these binaural differences in apprehending the distance and direction of sources of sound. If the approximate loudness of a sound at its source is known, the weaker it is heard, the greater will be the apprehended distance of its source. If the stimulation is slightly more intense on the right side, that small difference is interpreted to mean that the sound is coming from the right. Greater intensity for the left ear leads to localization of the sound to the left. If there is no cue from vision, without bias from previously acquired knowledge regarding the source, a sound originating in the vertical plane between the ears is likely to be incorrectly localized. In addition to differences in intensity and wave phase (time) for the two ears, knowledge of the probable source of the sound contributes to the perception of direction and distance of sounds.

Perception of movement. Moving objects within our field of vision produce changes in the stimulus-pattern on the retina. This applies whether the eyes remain fixed on a stationary object or follow the moving object. In the former case the stimulus-pattern from the object moves across the retina; in the latter case the whole background pattern shifts. These changes in retinal stimulation provide the cues for our perceptions of movement. It is apparent that previous experience has a lot to do with the apprehension of movement, especially in those cases where the awareness of changes in location depends upon the cues mentioned above. If an object is seen now in one place and the next instance in another, we are likely to perceive it as moving from the one position to the other. An object that appears to grow steadily smaller in the absence of surrounding points of reference may be seen as receding; one growing larger may be perceived as approaching. Predispositions and knowledge of what is probably happening greatly influence our perceptions of movement.

Illusions. The role in perception of trends and predispositions acquired from former experiences is revealed by many false perceptions where the established ways of interpreting sensory cues prove inadequate. Movement is likely to be perceived with a change in spatial relations within the visual field. Sometimes it is referred to the non-moving object. Suppose you are seated in a train standing at a station and looking at another train on the next track, headed in the opposite direction. If the other train starts, you may get the illusion that your own train is moving forward. Your expectation of starting would no doubt be a factor in causing the incorrect perception. Standing on a low bridge looking down on a swiftly moving stream may give one the illusion of moving rapidly upstream. Placing a pencil between the tips of two crossed fingers gives the tactual illusion of two objects instead of one. Under ordinary circumstances the fingers are not crossed and it would take two objects to stimulate the outer sides of the two adjacent fingers. The patient reports pain in the amputated foot because he is localizing the pain, derived from nerves which formerly brought impulses from the foot, according to his established habits of localization. The building across the street appears unusually large in a fog, because the haziness has come to mean distance, and a distant object makes a relatively small retinal impression. Here a hazy object makes a large impression. A distant object must be very large to make a large impression. Hence, we get the appearance of unusual size because the cues are contradictory. Likewise, the unusually clear atmosphere makes a distant mountain seem nearer than it really is, because usually the distant objects are less clear than those nearer.

First sight at eighteen years of age. The part that learning plays in perception is difficult to realize because much of the learning takes place so early in life. A baby cannot tell us how his perceptions develop. Perceptual habits are so well established before one is able to reflect on them that the process of identifying objects by our senses seems wholly natural. There are, however, several cases on record in which persons born blind have been given sight by means of surgery after many years of experience without vision. Upon receiving sight these persons have at first a confusing array of colors, strange shapes, and shadows which they are not able to understand or interpret. One such person who had congenital cataracts on both eyes making him ninety-seven per cent blind during his childhood was given sight at the age of eighteen by a surgical operation. He reported that when the light first flooded his eyes everything seemed hazy, with no definite forms, or arrangement, and with no perspective. The room seemed full of objects new and strange. He did not recognize anything about him at first. The doctor took him to the window and asked him if he saw the hedge across the street. He replied, "No, Sir," for, as he said, he had no idea which among the many strange forms was the hedge. He had to learn what a hedge looks like. Then he asked the doctor where the curb of the street was. The doctor explained which form was the curb. He could see it then. Later he went to a motion-picture theater. He found it very confusing because so many things were portrayed that he did not recognize. When he came from the theater he saw the stars for the first time. He was so amazed and delighted that he thought it strange that other people were not looking at them too. When he returned to school and old friends came up to congratulate him, he could not tell who they were until he heard them speak. He misjudged distances at first. He had experiences such as reaching for an object and having his hand go beyond it. There was much trial and error in his learning to judge distances from shapes, shadows, and angles (2).

Activities by which perceptions are modified or developed. The "experiences" which contribute to the development of perceptions are actually functions or activities of the organism. These activities are to a large extent themselves perceptual. Just as we acquire motor skill through repeated action so we acquire skill in perception by repeatedly perceiving. Our observations of today are the result in a large measure of our past perceptions, and what we observe tomorrow will be governed in part by today's perceptions.

While perception may be the most fundamental function involved in extending and refining our perceptions, any or all of the other forms of activity may serve to make such modifications. In the infant, motor activity is an important source of perceptual development. Swinging arms and kicking legs make contacts that provide experiences out of which concrete objects emerge. Placing objects in the mouth yields a combination of impressions, tactual, gustatory, kinesthetic, and visual, that become organized into perceptions of specific things. Nursing, crying, feeling comforting pats, and hearing the vocal efforts of adults trying to attract his attention lead to the differentiation of persons from inert things. Later handling things, exploring with eyes and hands, lifting, shoving, walking, running, jumping, climbing, tearing, breaking, bumping, falling down, getting hurt, reaching for things, twisting, pulling, clawing, kicking, rolling, and romping all help to build up the child's ability to discern the nature of his physical surroundings through his senses. As the years advance, action continues to contribute to the development of perception. The sight of a flat tire means more to one who has had to change tires on the road than to one who has never had such an experience. The perception of a gang of men working at hard labor cannot be the same for a person who has never done a hard day's work as for the man who has earned his living by arduous toil. The man who has lifted heavy things can see weight, he can feel the strain as he watches another struggling with a heavy load. Perceptual meanings are enriched by action.

Perceptions are enriched also by inspection. The sight of the earthworm carries a fuller meaning to the student who has dissected one in the biology laboratory, and has examined it in systematic, piecemeal fashion. Search contributes to the alteration of perception. Having been asked to find an obscure object in a picture, and having done so, the observer is likely, upon being shown the picture later, to apprehend at once the part previously discovered through the search (5*a*).

Comprehension sets new trends for the determination of perception. The student of botany sees things unnoticed by others as he walks through the woods. The student of astronomy not only sees constellations that escape the attention of another person, but his perceptions carry a meaning not possible to the uninformed in this science. Study in any field inclines an individual toward the perception of details or aspects of things he otherwise would not notice.

Finally, problem-solving thinking is a means of developing perceptions. In a study by the writer the attempt was made to compare the functions of perceiving, searching, and thinking. In order to secure comparable data for these three forms of operation, pictures were presented and a question designed to set off perception, search, or thinking was asked for each one. One of the pictures used for thinking showed a highway along either side of which were rows of trees. The question was, "Were these trees planted by man?" The question aroused a problem, which set off a real though simple bit of thinking. The subject sought for a clue and found it in the straight alignment of the trees. Nature does not plant trees in straight rows. Hence, the conclusion was reached that these must have been planted by man. In order to see what would occur under repetition, this same picture was again presented later in the experiment with the same question. At first the subject thought the experimenter had mixed up his pictures by mistake, but he decided to carry through the instructions and report as requested. He reported that his experience meant, "This is familiar, trees in a row, planted by man; that is the question he will ask." He then tried to recall his previous solution instead of trying to work one out again. Thus, recall took the place of thinking. As the picture was exposed for the third time there took place, before the question was asked, an immediate apprehension of the picture as a whole with the additional meaning "trees planted by man." Thus, a new meaning became incorporated into the perception of this picture as the result of solving a problem having to do with the picture. At first the subject simply saw various objects in the picture, including a road and trees; later he apprehended the trees *as planted by man* (5*b*). So the fruits of thinking enhance the meanings which appear in perceptions.

Children's perceptions. Another approach to the problem of the development of perception is through the consideration of differences in perception at the various age levels. In general, the child's perceptions are meager, vague, indefinite, and lacking in detail. They involve for the most part reactions to gross and unanalyzed wholes. The infant first becomes aware of certain elements of his environment that stand out as strikingly different from the rest of the surroundings. A loud noise against the otherwise comparative quiet of the room, an abrupt tug on the blanket that covers him, a face that comes into view, or the contact of his lips with the nipple set off certain reactions. At first these things are fused with the general situation. As he reacts to these in different settings they gradually become disentangled from the mass situation, take on the quality of individuality, and become more or less distinct items of the objective world. The sequence of development, like that of the motor activity, is from mass to specific. Upon looking at the books in the psychology section of a library, for example, an infant probably would experience only a broad, loosely patterned, variegated expanse; the five-year-old would see a lot of books; the high-school student would see many books on psychology; while the college student of psychology would see the particular works of several well-known psychologists.

In the first weeks of life the sense organs appear to be capable of effective functioning, but the experiences arising from them are indistinct and poorly organized. During the first year the perceptual ability of the infant develops rapidly. His behavior reveals his growing awareness of objects. In the first few months he acquires the ability to distinguish persons from inanimate objects. His eyes follow an object moved in front of his face. He reaches for and grasps small objects, inspects and manipulates them, and turns his head toward the source of sound. The ability to recognize his mother is manifest about the third month. When first her face is singled out as an object of perception, it appears that he sees it as a whole. Later the eyes, nose, and mouth are distinguished as discrete parts. By the fifth or sixth month he discriminates between strangers and familiar persons, and begins to show fear of strangers. About this time he first distinguishes between a friendly voice and an angry or threatening voice. The ability to learn to distinguish between simple geometric forms, such as circles, squares, and triangles, has been found in children as young as six months (7). By the end of the first year the child's world contains many objects known and recognized by him through perception. His needs and the outcomes of his reactions are important factors in determining what perceptions develop during this period.

During the preschool period the perception of objects continues to develop in the direction of distinctness and precision. Spatial and temporal relations are, however, discerned very imperfectly. Three-year-old children have very imperfect notions of the meaning of "near" and "far." Even four-year-olds have not completely learned to use the spatial cues of relative size, shadows, and converging lines. Children's perception of size is frequently faulty because they have not learned to allow for the factor of distance. Curti reports the case of a little boy at the age of three who thought horses seen at a distance were tiny horses, and of a little girl four years old who thought her father was getting smaller as he walked away from her (3). Early space perceptions in children appear to depend mainly on touch and exploratory movements. These are gradually transferred to vision. The ability to localize points touched on the skin is well developed before the age of three, and school children are as adept as adults in two-point tactual discrimination.

The placement of certain tests in the new Revised Stanford-Binet Test of Intelligence shows something of the perceptual abilities at the early age levels. A child two years old places three blocks, circular, square, and triangular in shape, in a form board after being shown how to do it; identifies such objects as kitty, button, thimble, cup, and spoon; points out the hair, mouth, ear, and hands of a pictured doll; and identifies certain objects by their use. In the third year he names various pictured objects. In the latter half of the third year he can tell which is the longer of two match sticks, two inches and 2½ inches long respectively. In year IV he is able to name three things seen in a picture, to discriminate eight out of ten geometrical forms, and to tell which is the prettier of two pictures of human faces (14).

A number of studies have revealed that young children are woefully ignorant of the most commonplace things. It appears that much that passes before their eyes is never seen. They usually know best the things they handle and the things they encounter in their home life. Their knowledge of things encountered in their walks and travels is less exact. New experiences are interpreted in terms of former experiences. Hence, observations for which there is inadequate preparation or background are likely to be unreliable sources of knowledge. After about the third year children's imagination becomes very active. This often colors and distorts their perceptions, sometimes making them fantastic. They may see the clouds as strange beasts, or perceive thunder as noise made by God rolling barrels about. A little girl seven years old had heard about a vaudeville performance in which colored lights were used in such a way as to produce changes in the color of the performer's costume. Later the girl reached home breathless, and excitedly related that she had seen a man coming down the street with a red dress on, and that as he came toward her the dress turned from red to green, then to yellow, and to blue. It had frightened her, and she had run all the way home. She was sure that what she had seen was real.

Individual differences restrict the value of generalizations here as in all matters of human development. Yet certain general trends of perceptual growth may be observed. By the end of the second year the perception of objects is fairly well established, but throughout early childhood objects and persons are likely to be apprehended as more or less isolated or disconnected items. A child of three years can enumerate objects seen in a picture, but description and interpretation require a higher degree of mental development. Perceptions of size, distance, and form are relatively crude in the preschool child, and spatial and temporal relations are imperfectly grasped at this age. The ability to apprehend relations improves as the child grows older and learns to interpret the various cues commonly employed.

As the child grows to maturity, his perceptions become richer and more definite in detail. Through cue reduction an older child is more capable of apprehending an object or situation when only a part of it is presented. In later childhood imaginal supplementation serves to fill in the gaps in the stimulus-pattern without the fantastic distortions common to young children. As the child grows older, his past experience plays an ever-increasing part in his observations. This gives stability to the perceptive functions. The little child's perceptions are much influenced by his present mental set, his emotions, and suggestion. This is true of an older person's perceptions also, but to a lesser extent because of the greater weight of past experience. If, for example, you were walking along a dark street with a small child and pointed out the dark form of a bush and said, "See that bear over there," he would probably see a bear. But if you tried that on a high-school boy or girl, it would probably not provoke the perception of a bear.

As adolescence is approached, the qualitative analysis of objects appears, and perceptions become more abstractive in character. A further development, which comes as the child moves toward maturity, is the acquiring of symbolic perceptions in which the object is perceived, not for itself, but for what it represents. Examples are found in the meanings of words acquired as language is learned, and in the meanings of various signs. The acquiring of these prepares the way for creative thinking and the solving of problems on the level of thought.

THE IMPROVEMENT OF PERCEPTION

From the foregoing discussion it will have been seen that perception develops pretty well without special training, through the various activities of the child. Without schooling, without tutors, the child will learn to perceive. Given a normal equipment of bodily organs he cannot help learning to perceive. His survival requires reactions to the objects of his environment, and out of these reactions perceptions take form. Yet without guidance and the assistance of instruction there may be many deficiencies and inadequacies in this function, which is so fundamental to the whole mental life of the individual. Perception is of such basic importance to the individual and his educational progress that its improvement becomes a part of the task of every teacher. Because it does attain a considerable degree of respectability before the child comes to school, because it develops to such a large degree through incidental learning, it is too often accepted as a ready-made vehicle for stocking the child with information. However, the facts revealed by the study of perception make clear the need for serious attention to the deliberate cultivation and training of this function. Probably the best work in this type of training has been done in the kindergarten and in our schools for the feeble-minded. Here the need for such work is more easily appreciated because the lack of perceptual development is more apparent in the very young and in the mentally deficient. But much can and should be done at all levels of the educational program to foster better habits of observation and more effective use of the sensory equipment provided by nature. To be educated means to have eyes that see and ears that hear.

Perceptions are made keener and more reliable by training. Observations of the common run are often notoriously unreliable. This is true not only of little children whose lack of experience, suggestibility, and fanciful imagination so often are responsible for faulty or inadequate perception, but of adults as well. Testimony on the witness stand must be sifted to get at the truth. Much that is incorrect in testimony is due to faulty memory, but much of it is due to deficiencies in the observations upon which the testimony is based.

The unreliability of ordinary observations is due to a variety of causes. Faulty vision or hearing may be a contributing cause. Mental sets, biases, prejudices, anticipations, moods, and emotional states of the observer color and channel the course of his observations and determine in a large measure what he sees and hears. The event observed, as in the case of an automobile accident, may occur so quickly that one does not have time to see all that takes place, or the situation may be so complex that one sees only a part. These sources of error or incompetence may be overcome to a large extent by adequate training.

The most exact and reliable knowledge derived from observations is found in science. Here special measures are taken to overcome or offset the factors that cause error. In the first place the scientist is a trained observer. In making observations he must maintain an attitude free from personal bias. He seeks to discover the facts, not to prove a point. He knows how to proceed in order to make a careful and systematic survey. He repeats and checks his observations. He uses instruments to extend the limits of his own organs of sense. His training steers his observations. He is not infallible, but the products of his perceptions are more exact, more verifiable, and more dependable than most nonscientific information.

The results of perceptual training may be seen also in the alertness of the proofreader in detecting mistakes in printing. It is manifest in the cleverness of the housewife in selecting the tender steak at the market. It is shown in the work of the inspector in a manufacturing plant whose business it is to detect any flaws in the finished product. The trained professional buyer for a clothing store is especially adept at distinguishing the various qualities of cloth. Expert tea tasters are noted for their acute perceptions of minute differences in the quality of the brew. Persons deprived of sight learn to make keener use of their auditory mechanism than most persons with normal vision. The experienced hunter knows by the tracks in the snow what game has passed. The musician detects in the tones the slight defect which passes unnoticed by the untrained listener. In every field of human art and endeavor the perception of the expert, the well-trained, the fully experienced, are keener, more critical, and more analytical than are those of the novice or the uninitiated.

Fostering the development of perception in children. The young child should have freedom to run about, to explore his environment, and to handle, taste, and smell the things he encounters. Reactions to objects are essential for the growth of his ability to perceive adequately. They take on meaning in proportion to the activity connected with them. Being shut up in a pen day after day is hardly conducive to his best interests. If this should be necessary at times, the mother should see to it that he has a sufficient supply of toys, blocks, and bang-able things to manipulate, things that squeeze easily, things that make noises, things that can be pushed, so that he may have the opportunity to learn. He should have the opportunity to dig in the dirt, tear up paper, and play with other children. Every young child should have the pleasure and educational experience of splashing in water, watching the honeybee, feeling the soft fur of a kitten, touching the hard, smooth, cold surface of ice, smelling the fragrance of flowers, and tasting the things he can get to his mouth. His questions about the things he meets should be answered in a manner that will enrich their meanings for him. He should be told the names of things, for this will not only help build up his vocabulary but will aid in the process of differentiating specific objects.

An environment which affords the opportunity for activity and varied experiences with things is favorable to good perceptual development. One investigation indicated that children from poor districts do not have as good or well-developed perceptual ability as those from good districts (13). A child should, if possible, be allowed to visit places outside of his own immediate neighborhood. For the city child a trip to the zoo, a visit to a farm, or a vacation at a summer camp will be a valuable experience. Recently a group of high-school students were brought to Boston by their teacher to participate in an educational conference, and several of them on that occasion had their first ride in an elevator though they came from a town only eighteen miles from the city. Country children will be benefited by a visit to a city where they can hear the sounds and see the panorama of city life.

The kindergarten is well adapted to contributing experiences that have excellent developmental value. Here the child's perceptual possibilities are drawn out by his play with other children, by making forms in sand or clay, by weaving which calls for the discrimination of colors, by singing, by finger painting, and by the many other interesting activities that afford direct sensory stimulation and the opportunity to respond, explore, and manipulate.

Developing perceptual trends. By perceptual trends we mean the sets, the predispositions, or tendencies derived from former activity which govern the course of our perceptions. They are established in much the same way as action habit tendencies. They may be thought of as habits of perceiving. Just as we secure the establishment of a motor skill, or a habit of doing a certain thing at regular times, by telling a child what to do and how to do it, and by providing appropriate incentives, so we secure the establishment of perceptual trends by instructing the child to watch for certain things, by directing his observations, and by seeing to it that the experience into which he is led brings satisfaction. Instruction is the source of a temporary set (corresponding to the task) which determines the immediate perception. The perceiving, especially if repeated, establishes the tendency (corresponding to the habit) that determines later perceptions.

To develop perceptual trends the first step then will be to secure appropriate perceptions. The objects and materials to be observed are important factors. Natural objects, models, charts, and other concrete materials are most suitable. The child may be asked to describe what he sees, draw pictures of it, or write a composition on it. Questions give a definite incentive and direction to perception. Suppose a picture is being presented. A child may be led to see many details, which otherwise might entirely escape his attention, if such questions as the following are asked: Do you see anything unusual about the house? How many persons are there in the picture? What kinds of flowers are there? What is the boy in the picture doing? What does the man have in his hand? Then the teacher may have the children themselves make up questions for other children. Here they must take the initiative themselves in observing details. Another means is to show a group of objects or a page of several pictures for a few seconds and have the children later tell how many things they can remember. This may be made into a sort of game. Group discussion of a picture or of what is seen on a field trip may be made stimulating. In all of these procedures the teacher has the opportunity for correcting wrong impressions or faulty observations and in so doing helps the child to become more accurate in his perceptions. For this reason also, conversations with children about their experiences are recommended.

Children naturally seek adventure and new experiences. They like to explore. Even the three-year-old has been known to wander off from home to investigate the curious world beyond his own yard. The teacher may well utilize this natural curiosity and desire for experiencing new sights and sounds. One teacher succeeded in arousing the interest of a boy who was indifferent to his schoolwork by telling him he was to describe to her every morning one interesting thing he had seen on the way to school. This assignment included the subtle suggestion that if he noticed things around him he would find interesting things. This boy was soon reporting to his teacher not one but several interesting things he had seen and his attitude toward his work quickly improved.

Field trips and movies. The observations on a field trip or of a classroom motion picture, excellent means of instruction, need to be directed. Preparatory instruction about what to look for should be given to secure best results. One of the disadvantages of these devices is the danger that attention may be diverted from the important things to some trivial and irrelevant, though to the child interesting, detail. It is well, also, to announce that a report on the subject of the trip or picture will be expected. This will tend to make the pupils more alert and stimulate them to make careful observations. This report may be either oral or written. In either case, the excursion or the movie should be followed by a discussion in which false or erroneous impressions are brought to light and corrected.

Perception and language. Perception plays a fundamental part in the acquisition of all the language skills. First, there is learning of the names of various objects. A child learns the name of an object by hearing it spoken by another. The vocal sound becomes associated with the object in his experience and thereby comes to mean or represent that object. The mother, for example, says, "Doggie," as she hands the child the toy dog. After a few repetitions, "Doggie" means the toy dog. As he strokes the kitten he hears someone say, "Kitty," and by this association the sound means that little soft, furry, moving thing. He learns in this way the names of many objects before he can say the names himself.

The next step in the development of language is the emergence of speech. About the end of the first year the baby begins to utter his first words. As he sees the kitten come into the room, he says, "Kitty." Having heard "Daddy" many times in connection with seeing his father, he says, "Daddy" when his father appears. At first the meaningful reference of these words is not very specific for him. He may call a fur coat "Kitty" or say "Daddy" to any man he happens to see. This indiscriminate use of names is like the generalization of the conditioned response. It is overcome by further learning through which is developed the ability to make appropriate distinctions.

The basis of the whole process of speech development is auditory perception of spoken words. The words a child learns to use are those he hears. A deaf child does not learn to talk because he does not hear the speech of others, and partial deafness is a decided handicap for the development of speech. The habits of speech are normally acquired by hearing and imitating other persons. A child's pronunciation will be like that of the people with whom he is associated. If he grows up in the Middle West, he will sound his *a*'s and *r*'s noticeably different from the child reared in New England. A little girl who learned to talk in New England visited cousins in Michigan. She called her aunts in Michigan, "Ant Bessie" and "Ant Margaret," but those in New England were "Aunt Ethel" and "Aunt Ada." Since the quality of a child's speech depends largely upon the speech he hears, it is important that he have good examples to imitate.

The child's perception at the age when he is learning to talk is very imperfect. He may have normal hearing and the pronunciation he hears may be faultless, and still his own pronunciation may be faulty, because he fails to hear the fine variations and delicate shadings of sounds characteristic of good speech. Children often need special training to improve their ability to hear various word sounds accurately.

This imperfect auditory perception of word sounds may affect not only the child's pronunciation unfavorably, but may be responsible for confusion in the next language steps, his learning to read and spell. For example, in a composition by a seventh-grade girl appeared the following errors in spelling: *hunerds,* for hundreds, *Washinton,* for Washington, and *witch* for which. The relation of these errors to faulty pronunciation is obvious. This child wrote these words as they sounded to her and as she herself pronounced them. Her difficulty was not due to home influence, nor to bad pronunciation by the teacher. Her parents were well educated and spoke very well. Failure to hear properly was a basic cause here of bad spelling. This girl needed "ear training" to help her hear the word sounds correctly.

In order to learn to read successfully a child must be capable of good auditory and visual discrimination. Reading begins with the child's oral vocabulary. He knows the spoken word first. This is associated with the printed word. Then after the pattern of learning by conditioning, the visual form takes on the meaning carried by the speech sound. If the learner does not hear the essential and distinguishing elements of the spoken word, he may have trouble in making this shift to the printed form. A large proportion of the children referred to the Boston University Educational Clinic as reading-difficulty cases have shown lack of ability to notice similarities and differences in the sounds of spoken words (8).

Visual discrimination is essential for reading, for if the learner does not distinguish relatively small differences in word forms, he will confuse such similar letter patterns as *house, louse,* and *horse.* To distinguish between *new* and *mew,* for instance, requires rather keen perceptual discrimination, and it is not surprising, in view of the fact that perceptions are so imperfectly developed at the first- and second-grade levels, to find that for some children these words look alike. Durrell (4) has stated in reference to this matter that: "Children learn to recognize words by the general appearance of a word rather than by exact letters. Often a part of a word stands out and serves as a cue for the recall of the whole. Cues used by children to recognize words often lead to errors. The word *dog* is commonly misread as *girl* probably because the *g* is the cue for the latter word." He gives inadequate perception of the printed word as one of the causes of reading difficulties, and in his chapter on word meaning and recognition he presents a number of exercises designed to train children to observe differences between words that are similar in appearance. Murphy has developed a series of exercises for training the auditory and visual word perception of young children and has demonstrated that their use facilitates the process of learning to read (9, 10).

To recognize a word means to perceive it as one already known or experienced previously in some manner. A word cannot be recognized without being perceived any more than a person can be recognized without at the same time being perceived. But just as a person may be seen without being recognized, we may have word perception without word recognition. If, for example, we should see some printed matter in an unfamiliar foreign script, we could perceive words, that is, the letter patterns would be, to our way of interpreting the experience, words of an unknown language, but we should not recognize any of the words because we had never encountered them before. If someone else were to pronounce one of them, we could not pick it from the group. A child is said to recognize a word when, after hearing it named, he points it out from a list of several words.

One may recognize a word without knowing its meaning. When we come upon a word the meaning of which we do not know and go to the dictionary for its definition, we recognize the word when we locate it. We get its meaning from the definition. It is a difficult task for small children to learn to recognize words without knowing their meanings. Word recognition and word meanings should be taught together.

Reading is psychologically a very complex process. The successful reader must not only perceive accurately small differences in the printed word forms and know the meanings of separate words, but beyond this he must be able to comprehend the meaning of sentences, paragraphs, and topics. The process of comprehension will be discussed in a later chapter.

ATTENTION AND PERCEPTION

Attention as a selective process. We have seen that the activity of perceiving starts with the excitation of the sense receptors by physical stimuli, and runs on its course with the transmission of neural impulses to the cortex and the organization of the resulting sensory qualities into meaningful patterns. At any moment, however, the organism is assailed by a multiplicity of stimuli too great to be utilized in perceiving. The perceptive functions are limited with respect to the area of stimulation they can manage. Hence, a selection must be made with respect to the stimuli assailing the organism at one time. The process of selection is attention.

Attention is not a mental power that does the selecting. It is the organism itself that selects. It favors certain stimuli and disregards others according to its own needs, inclinations, state of being, and its activities at the moment. Some of these conditions which determine the selection are transient, as, for example, the activity in progress or sets induced by a command or a suggestion from the teacher; others, which have their sources in the history of the organism and its racial development, are more constant factors. These sets, biases, and habits give orderliness to the apprehending of our surroundings by providing a right-of-way for clarity of perception in one area of stimulation while other areas are disregarded or are made to wait their turn.

Studies of the attention aspect of perception have been largely concerned with three problems: first, the relation of attention to clearness of the experiential pattern; second, the number of things that can be attended to at one time; and third, the factors which determine attention.

Clearness. Through introspection one may observe the effects of attentive selection on conscious experience. If the reader will for a moment observe his patterns of experience, he will note that they are constantly shifting, and that at any given moment some parts of the conscious field stand out clearly while other parts are obscure. As you look at the clock on the mantel, the visual pattern is dominant. As you attend to the clock you are only vaguely aware of other objects in the room. The radio sounds are unclear, and you fail to hear what the announcer says. If, as you gaze with eyes fixed on the clock, your attention shifts to the speaker's voice, the vocal sounds become focal and clear, while the visual qualities become obscure. Perceptual experience is organized with respect to different degrees of clearness into a foreground-background pattern. The constant shifting of the foreground gives emphasis now to one, then to another part of the general scene.

The range of attention. Regarding the second problem, we find that one really attends to one thing at a time. Quick shifts of attention may enable a person to observe several things in a few seconds, or to carry on two operations that require attention. Where several things occupy attention at the same moment, they are taken as a unit. One may apprehend clearly a group of five dots, a flock of chickens, or a forest. In such cases one does not attend to the individual dots, chickens, or trees.

Determiners of attention. Regarding the factors which determine attention, we stated above that they were factors of bias or habit within the individual. We must now examine the conditions more fully. First, the fact that the factors controlling attention lie within the individual does not mean that factors in the external situation have no influence. Just as the instructions from another person may give rise to a task-set, so commands or suggestions from another person may give rise to sets that govern attention. When the teacher says, "Look here," "Notice the band on the pigeon's leg," or, "Tell me what you see in the man's hand," his words serve to direct the attention of his pupils to things he wants them to observe.

1. Primary determiners of attention. There are certain characteristics of objects or stimuli that usually are potent for securing attention. Large, moving, novel, unusual, or isolated objects, and those in contrast with their surroundings are usually favored items of attention. Intense, continuous, repeated, or changing stimuli make a strong bid for attention. These factors appear to dominate the attention of animals and play a relatively larger part in controlling attention of children than of adults. They appear to derive their potency from inborn predispositions. It may be that such predispositions have come to be a part of the biological heritage because of the survival value of attending to things that are large, strange, moving, and to stimuli that are intense, changing, and recurrent.

The individual's needs, organic and otherwise, exert a powerful influence on attention. If one is hungry, he looks for a restaurant and notices signs of food. Thirst causes one to notice wells, pumps, faucets, or any other indicator of drinking water. The need for security causes one to be on the alert for danger signals.

2. *Acquired determiners of attention.* In general, we attend to those things that have significance or value for us. Predispositions for attending to certain things beyond those for which we are innately prepared are soon learned. Acquired determiners of attention develop out of experiences, and as the child advances toward maturity, they assume an ever increasing role in the control of attention. From the need for security grows the desire to please others and to be liked by one's associates. This desire is an important determiner of attention. The child listens to the teacher to please her or to avoid her displeasure. One may give his attention to a speaker in order to show that he has good manners. Also, potent factors in attention are acquired interests. An interest in flowers, birds, music, or airplanes inclines one to select these things out for observation. Education should develop new interests. In so doing it establishes sets that will lead the student to see what he otherwise would overlook. It is a most effective way of improving the student's perceptions and habits of observation.

Attention and search. There is something forward reaching about attention, which may be observed in the alertness for what is to come. Woodworth speaks of attention as the exploratory phase of observation and of perception as the discovering phase (15). Bentley also points out this active feature of attention and says that attending to a thing often involves a close integration of search with other functions (1). This is seen in the expectant attitude of attention aroused by the words "Look!" "Listen!" by the straining to hear the words of a whispered conversation, by the craning of necks to see the passing parade, and by various motor accompaniments and adjustive postures of an attentive attitude.

Attention in children. One of the practical problems of a teacher is that of sustaining the attention of the members of a class. Little children are sometimes said to be incapable of sustained attention. But this is hardly an accurate statement. As stated above, the attention of a little child is more completely governed by the characteristics of the things that appeal to his receptors than is the adult's. His attention is likely to shift rapidly from one thing to another in his environment. The perceptive functions predominate in his mental life. He is readily distracted by noises, bright colors, moving things, and bodily discomfort —more so than the older child or adult. This is as we should expect in view of the fact that he has not had time to acquire the strong social motives and the controlling interests that play so important a part in the determination of attention in the adult. Nevertheless, under the right conditions a child can give attention over a considerable period of time. It is largely a matter of motivation. At the movie, or at the circus, or in hearing an interesting story, the child will have little trouble in keeping his attention from wandering. Attention is so important a matter for learning that it must be aroused, directed, and sustained by the teacher if he is to meet with any degree of success in his work. It is futile to disregard the laws of child nature in attempting to accomplish this. It will do little good merely to demand attention and then proceed with a dull, monotonous, and meaningless presentation of facts. The secret of securing and maintaining attention is change, novelty, interest, and meeting a need.

What Perceptions Shall We Train?

No attempt will be made here to list all of the perceptions which the school should endeavor to develop. The needs of various individuals are so diverse and the demands of different vocations so varied with respect to effective perception that only general principles can be stated. There are certain needs which are well nigh universal. These must be our guide.

Perceptions of natural objects. Every individual must get on in a world of natural objects. The perception of *natural objects,* their nature, qualities, and form is a basic necessity. A good start in this direction has been made by the time the child enters school. But the imperfections and limitations of object perception at this age are so great that the school has both an opportunity and a duty in enrichment, extensions, and refinements. Through nature study and science, on the field trip, and in the laboratory, the pupil's eyes may be quickened to see more penetratingly into marvels of nature.

Space perception and orientation. Because adjustments of various kinds must be made to the spatial aspects of the contents of one's environment, the individual needs a well-developed ability to apprehend spatial relationships. He must learn that a man walking away is not really getting smaller, and that railroad tracks do not actually draw closer together in the distance. Since nearly everyone today drives a car, the ability to make quick estimates of distance and speed is most essential for the welfare and safety of the driver and of the pedestrian. An important form of space perception, which should receive attention in the school, is orientation with respect to the points of the compass. All children should know how to get their bearings with respect to north, south, east, and west. One youngster, when asked what direction is Australia from India, replied that he knew how it looked on the map, but he could not answer, "Southeast" because he did not know the names of directions on the map. The geography class should foster correct orientation perception.

Esthetic perception. Every child should learn to see the beauty in his surroundings. The enjoyment of a beautiful sunset, landscape, picture, or music depends upon the degree to which perception has been established. To appreciate good music one must be sensitive to the figures and patterns of tones that make it good. To appreciate art the pupil must be able to see the shadings, rhythm, and balance by which the artist has expressed his purpose. The domestic-science class should be taught to see the pleasing details of an artistically arranged dinner table, and the fine points of good taste and design in clothing. The botany class should learn to see the beauty of the color patterns of flowers, not merely stamens, pistils, and petals. The literature class should be taught to see the beauty of the total pattern of the poem, not merely to tear good literature to pieces in a search for similes and metaphors.

Social perceptions. The school should contribute to the refinement of the child's social perceptions. It is important in getting along with people to realize their moods, attitudes, and motives, and to see quickly the effect of one's actions or words on others. Some persons are sensitive to social stimuli, while others are callous to them. Even a dog learns to watch his master's face for cues of approval. The successful husband learns to notice his wife's new dress or "permanent." The good teacher is sensitive to the attitudes and responses of her pupils.

Vocational training. Besides these perceptions, which should be developed in all pupils, there are those which are particularly essential for success in the various fields of study, in the vocations, and in the professions. The doctor, for example, learns the diagnostic significance of the appearance of the patient's skin; the fisherman knows the meaning of the tug on his line; the scientist sees more in his microscope than the untrained observer does; the carpenter distinguishes readily different kinds of lumber; and the farmer can tell when the grain is ready to cut.

Summary of the Chapter

Perception is an activity upon which most of our learning depends. It is the apprehension of things as present and of events as taking place. It is modified and developed through learning. All perceptions involve sensory experience and meaning. The meaning depends largely on the patterning of the sensory qualities, and sensory discrimination is essential to patterning. Besides material objects, we perceive sounds, materials, events, work, motives of others, relations, and symbols.

The modifications accomplished through learning include changes in the sensory patterns and in meaning. Distance, size, direction, and form are apprehended by means of cues that have been learned. When the customary use of these cues is not appropriate, we may have illusions or inadequate perceptions. Any of the psychological functions may serve to modify and enrich perception, but the development of perceptions in the early years probably results mainly from exploratory activity and perceiving.

The perceptions of young children are meager, crude, indefinite, and lacking in detail. Wholes are usually perceived before parts, and discrete objects are apprehended earlier than their spatial and temporal relations.

The keenness and reliability of perceptions may be improved by training. The school should give serious attention to the development of adequate perceptions. Children should be given opportunity to explore and manipulate, and should be provided with a variety of stimulating experiences. To develop desirable perceptual trends the child's observations must be directed. The question is a good means for guiding perception.

Perception plays an important role in the mastery of the language arts. Good auditory discrimination is necessary for speech development, and fine visual discrimination is essential for learning to read.

Attention is a process which selects the stimuli for perception. It provides clarity and dominance in the shifting sensory patterns. One really attends to one thing at a time, but grouping makes it possible to incorporate several items into one object of attention. Some determiners of attention are innate, others are acquired; some are permanent, others are transient. By innate predispositions one attends to large, novel, isolated, and moving things, and to stimuli that are intense, changing, or repeated. Purposes, interests, habits, and social motives are acquired determiners of attention. Attention is forward-looking and exploratory. It may be directed by questions, commands, or suggestions. Compared to an adult's, a child's attention is more controlled by the innate predispositions favoring intense stimuli, and novel and moving things. The child is easily distracted, but with sufficient interest and variety his attention may be sustained.

Education should seek to improve perceptions of natural objects and their spatial and temporal relations. Training should be given for the development of esthetic and social perceptions. The various vocations call for specialized perceptual training.

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CHAPTER XIII

MEMORIZING

Memory and imagination. Perception, as we have seen, is an activity through which the individual becomes aware of objects about him and of events that are taking place. It depends upon physical stimuli from the environment and the excitation of receptors for the essential sensory qualities of experience. Frequently, however, by means of other modes of functioning the individual slips away from the present. Through his memories, he reviews past scenes and relives to a certain extent his former experiences. The meaningful reference in remembering is to some past experience or to some object or situation previously encountered. When we remember a thing, we apprehend it as past. In imagination we anticipate the future, we make plans, we forecast, we suppose what has been, we daydream, and we think of certain kinds of things with reference only to the general characteristics of those things.

Mental images. The qualities of experience involved in memory and imagination are similar to those found in perception, and they appear in patterns that resemble the patterns found in perceptual experiences. We call their patterned units *mental images.* To illustrate, let the reader think of an American flag. Now if you have recalled a particular flag, say the one which you saw carried in the parade yesterday, your thinking of that flag was an example of remembering. If you thought of a flag in a general way with reference to no particular flag, your thinking was an example of imagination with general reference. In either case, if you reacted as do the majority of persons, you experienced a mental image of the visual sort. In it were the white and red stripes and the blue field with white stars. Here the qualities of white, red, and blue were like the visual qualities you have previously experienced when perceiving a flag. Your imaginal qualities were probably less distinct, and the pattern was probably a bit hazy and incomplete, particularly if your thought was one of a general reference, for then it was likely the result of many antecedent perceptions. The meaning may even have been carried for you in verbal terms by your saying "Flag" subvocally. In any case the object was apprehended without being present, and without light stimuli from it falling upon your retina. Such visual qualities as appeared to make up the visual image of the flag were provided by processes in your brain. In memory and imagination we use imagery corresponding to the other senses, though for most people the visual and the auditory are the most vivid and most commonly employed.

Association. The appearance and sequences of our memories and the various imaginational experiences are determined by functional trends that have already been formed and by other factors of set, which we shall consider later. A perception sets off a memory; one memory leads on to another; and ideas run their serial course in daydreaming. The sight of my real estate broker reminds me that I told him to try to sell our house, that I had intended to cancel this order, and then I imagine him coming to the house with a prospective buyer. My eyes fall on the large elm in the back yard, and I reflect that a few years ago I had carried that very tree in my hands and planted it where it now stands. A picture of an old friend sets off memories of experiences shared with him, and the odor of new-mown hay brings to mind scenes of childhood days on the farm. Sometimes a perception sets off imagination. The doorbell rings and we anticipate the appearance of an expected guest. As we look at the package marked "Not to be opened until Christmas," we imagine various things it may contain. The relations found in the sequences of such centrally aroused and sustained experiences are known as *associations.*

Associative tendencies. The functional trends by means of which we pass from the perception of an object to memories or ideas of things associated with it in our former experience and by which trains of thought are maintained, are called *associative tendencies.* They incline the course of functions toward the reinstatement of old association patterns. To understand the source of these tendencies, we must go back to the organization of perceptual experiences and consider a phase of this organization we have not taken up before, namely, the temporal ligations of perceptions into series or trains. It will be observed that ordinarily our perceptions are not isolated events. They usually are linked with other perceptions. We see the boy in the cart drawn by the pony. We see the train drawn by the locomotive and running on steel rails. We hear the factory whistle at twelve o'clock and see the crowd of workers coming out. We hear the author's name followed by the title of the book he wrote. We hear the thunder after the flash of lightning. In many ways the relation of belonging is here established.

The incorporated series may be longer. As our eyes pass over the landscape viewed from the top of a hill, we notice in turn a cluster of trees, broad fields of grain, farm buildings, and cattle on the distant hillside; and all of these experiences are combined to make up the "wonderful view." They belong together as integral parts of the rural scene. We enter a grocery store and observe in succession the boxes stacked on the counter, the shelves laden with canned goods, and the pleasing display of fresh vegetables and fruits. Here again, the various perceptions are joined together as successive phases of our visit to the store. Likewise the successive experiences of a weekend trip are ligated into the unit which we regard as the trip.

Moreover, the organism is capable of rehearsing these events and scenes in memory without the original stimuli and receptor processes, and the memorial rehearsal tends to follow the order of the original perceptual trains. However, so many and varied are the impressions from former experiences that there are likely to be alterations and breaks in the chain. Deviations from the original patterns may come from the blending and interference of traces from countless other antecedent functions. There may be omissions, and there may be filling in and substitutions from other earlier experiences. Breaks may be caused by the intrusion of potent stimuli from the present situation. Still the general fact remains that things experienced together in perception are likely to be thought of together in memory and in imagination.

If yesterday we saw an automobile accident at the intersection of Main and Arlington Streets, today as we pass that corner we think of the accident. Yesterday the perceptions of the street corner and of the accident were parts of an organized unit of experience. Today functional trends and associative tendencies left in the wake of that experience are brought into play by the sight of the corner and through them the perceptual apprehension of the corner brings the memorial apprehension of the accident. Next, we may recall that we drove from the scene of the accident to school, and that upon our arrival there we were met by the principal who told us of the plans for the fire drill to be staged in the early part of the morning. We recall that the children conducted themselves very well during the drill, but that it was difficult for them to settle down to work afterward; that it was a tiring day, and so on, with memory following memory for events and scenes related in the previous day's experiences.

Previously established associative tendencies also govern the appearance and sequence of the imaginational functions in revery, anticipation, meditation, and creative thinking. Because of repeated associations the thought of boy is followed by the thought of girl; table suggests chair; house suggests barn; grocery store, canned goods; pony, cart; dog, cat; and so on. In these cases we have objects that have been experienced together in spatial contiguity. The associative trends are established also by such relations as part-whole, cause-effect, opposites, and similarities. The principle of establishment is the same. The part is experienced in connection with the whole, effect is seen to follow cause, opposites are known as opposites only as they are apprehended in connection with each other, and in the case of thoughts of similar things the sequence is secured by the common features of the experiences.

Verbal associations. Words in spoken and written language stand for the various sorts of objects of experience. As carriers of meanings they render a great service in thinking. Here the distinction often made between action as a physical process and thought as a mental process breaks down. Talking aloud is a form of action; but is talking to yourself without uttering a sound action or thinking? The associative processes serve many different functions. Distinctions between the functions must be based on differences in mode of operation and their products. The behaviorists claimed that thought is internal speech based on muscular habits learned in overt speech (49). There is no doubt that much we call thinking is carried on in such a manner. The unuttered words here carry the meanings of rich and varied experiences. Especially in thoughts where the reference is general or where the meanings are abstract, words serve as effective bearers of meaningful experience. A very large part of our associative processes is verbal in character. So well do words act as substitutes for objects that verbal experiences may set off memorial or imaginal apprehension quite as well as the direct perception of an associate. For example, hearing a friend say he had sat on his lunch reminded the writer of a mountain-climbing trip of years ago when the lunch he was carrying became badly crushed.

Memorizing is largely a matter of forming verbal associations. To memorize a poem means to acquire the ability to recite it in exact order without recourse to the book and without any other form of perceptual prompting. The principles governing the formation of the associations of memory and imagination already described apply also to the establishment of the verbal associations. In paired-associates verbal learning we see or hear two words; they are connected in perception; later the first is presented to us as a "stimulus word" and we respond with the second. Our response may be in inner speech, in audible speech, or in writing, but it is evoked in the same manner as a memory that is touched off by a perception. In the case of serial verbal learning the recital is carried through by associative tendencies derived from the perceptual trains established during the learning.

Association and learning. The establishment, strengthening, and altering of the associative trends is learning. Associations are usually established in the first instance by perceiving things in related sequence. The reinstatement of these associations in memory, in imagination, or in recital tends to strengthen them; and new experiences of various kinds may alter them. As we have seen, the outcome of learning is a modification of the individual's mode of response, that is, of his functions. This form of learning affects not one but several functions. The bearing which it has on remembering and imagining we have considered. It is also basic, as we shall see later, to much of comprehension, and it is vitally important to problem-solving thinking; and if recital of memorized material is to be considered a form of action, then it modifies the course of action. The acquiring of knowledge is a matter of enlarging our associative resources.

Associative tendencies regarded as neural trends. Just as the ideational experiences themselves depend primarily upon the central neural processes, with mental images taking the place of the sensory patterns of the antecedent perceptions, so it is the nervous system that determines the sequence of these ideational experiences. We shall, therefore, not think of association as a kind of magnetic force that binds together two or more mental entities called "ideas," and by means of which one upon appearing in consciousness is able to pull in the other. By association we mean the temporal course of functions in memorial rehearsal, in imaginational trains, and in verbatim recital, resulting from the tendency of the nervous system to carry through its renewed operations on the lines previously established. The associative tendencies bear the same relation to the thought processes as habit tendencies bear to action. They are observed, as are habit tendencies, in the sense that repeated performances indicate an inclination toward certain types of response. They are regarded by hypothesis as neural trends.

Verbatim memorizing. Most of us have formed a great many associations with the things which we meet frequently in the course of our daily living. Thus, *church* may suggest: worship, preacher, building, bell, sermon, hymns, usher, pew, aisle, wedding, music, congregation, deacon, contributions, Sunday school, Methodist, religion, faith, altar, sacrament, choir, and so on. Now the chances are that on different occasions with different attitudes and sets, the mention of *church* will bring to mind different ones of these associated experiences. If you are worried over money matters, the thought of church may make you think of your pledge to contribute a dollar every Sunday. If you are hungry, you may think of the church supper. At Christmas time you may think of the music of your church. In other words, the total situation governs associative recall, and the response to a stimulus word made in one situation may be altogether different from that made to the same word in another situation. From a large number of possible associations which may recur there is selection, and the favored item may not be the same under different circumstances. What appears depends upon the relative strengths of the tendencies, the purpose, problem, attitude, mood, and other sets.

In such cases as we have just mentioned, our associations are, for the most part at least, formed incidentally. There is no forthright attempt to insure particular forms of reproduction. In verbatim memorizing, however, there is normally a definite purpose to acquire the ability to recite or reproduce in a fixed manner. An attempt is made to form a particular associative train and to strengthen it by repetition, so that the recurrence of a particular item of experience or verbal reaction will invariably be succeeded by the one that followed it in the learning situation. So the poem is read and reread until every word in every line can be recited in the precise order in which it is read. Spelling must be learned so that for each word the exact sequence of letters can be reproduced. A deviation from the order experienced in learning is considered an error, and the learning in that case would be regarded as imperfect or incomplete.

In paired-associates learning, where two items are learned together, the pair is repeated until the learner upon experiencing the first member will be able to recall the second. Such, for example, would be the learning of the dates of historical events, the capitals of states, the names of the authors of books, the foreign-language equivalents of English words, and the answers to simple fact questions, such as "Who is the Mayor of Chicago?" Still, other factors of the total situation are of such moment in reproduction that learning can never be so perfect as to guarantee with absolute certainty that a particular response will always occur as a result of a particular association. Sometimes a person cannot think of his own name. Memorizing is then the process of developing associative tendencies and making them strong enough to make probable that when certain perceptions or ideas appear they will lead to the memorial or imaginational apprehension of the associated objects of experience or to the verbal responses which represent them.

Functional modification in memorizing. The functions involved in memorizing are initiated and run their course under a task, which forecasts the eventual outcomes of this learning. This task arises from instructions from other persons, from the occasion, or from the individual himself. In experiments on learning in the laboratory, it issues primarily from the instructions given by the experimenter. Even here, however, the occasion or the subject may supplement the directions given by the experimenter. In the school the task arises from similar sources. The primary source is usually the teacher's assignment, but this is likely to be supplemented by other factors in the learning situation, including the child's own wishes and decisions.

Under repetition changes in function are brought about. These changes are of the same kind observed to take place in the forms of learning already studied. They consist of eliminations, inclusions, substitutions, and increased stability of performance. In the first place there is the elimination of the task or intent to learn. When the poem is recited after learning is accomplished, we no longer have the repetition with intent to learn. Besides the task, there is the elimination of the errors and of recourse to the book, which characterize the unfinished performance. Inclusions may occur in the form of added materials, which facilitate retention and recital. For example, after learning a list of unrelated words that contained the word *hot,* one subject reported: "The room in which the experiment was conducted was very warm, and when the word *hot* was flashed I naturally connected it with the temperature of the room and this helped me to remember it." Another reported that she recalled *mij* from a list of nonsense syllables because it suggested "midget," and she had taken care of a midget during her training in nursing. Substitutions appear in the replacement of the visual or auditory perception of the items in learning by the verbal reactions in recital. The successive stages of the total performance become more closely integrated and consolidated, so that once recital is started, it continues smoothly on its course to completion. In general, the function changes from reading or hearing a series of items to reciting it.

Memorizing in the school. Memorizing occupies a place of considerable importance in the work of the classroom. In many cases it is required when comprehension is what really should be taught. Better schools of today are less inclined to stress rote memorizing than those of the past because the myth that mental exercise strengthens the "faculties of the mind" has been thoroughly discredited. The memorizing required today is justified, not on the grounds that it strengthens the memory, but because of the usefulness of certain ready-made responses provided by it.

Fixed associations are essential in many subjects and useful in others. In arithmetic, the mastery of the number facts of addition, multiplication, and subtraction calls for exact memorizing of the paired-associates type, after these facts are thoroughly understood. Spelling involves the memorizing of the serial order of the letters in a word, and sometimes of rules. History and geography call for the paired learning of a certain number of facts, such as dates, events, names, and places as the nucleus for the comprehension of topics; though serial learning by rote of lists of facts is rarely if ever justified in these subjects. In the foreign-language class there is usually the pairing of English words and their foreign equivalents in the early stages of vocabulary building. Shorthand symbols are paired with the words they represent. In mathematics and science there are formulas, axioms, laws, and definitions to be memorized. In the literature class, some quotations, poems, and names of books and their authors usually must be learned. Then we have the graduation oration and the plays presented by the dramatic club, which require thorough memorization.

FACTORS IN THE MEMORIZING OF VERBAL MATERIAL

Repetition. Under favorable conditions one occurrence of a combination of experiences may be sufficient to set up enduring associations. This happens in the case of many events in our lives, which are remembered. One reading of a poem may enable us to reproduce a number of ideas expressed in the poem; but if it contains more than a few lines we should probably not be able to recite it verbatim without repeated readings.

The number of items that can be reproduced in correct order immediately after one impression is called the *memory span.* It differs for different kinds of material and for different modes of presentation. Generally speaking, for novel material such as nonsense syllables the memory span is about six or seven items. The average memory span of college students for digits is about eight without practice. It may be raised to a limit of about twelve through intensive practice. For logically related sense words or numbers that fall into familiar groups such as 1492-1942-1066, it may be considerably larger. But suppose we present to a subject the following series: 9-7-4-6-8-2-5-1-8-4-2-7-3-9-6.

His reproduction after a single presentation would likely be incomplete. He might give three or four of those at the beginning and some that fall near the end, but there would be omissions and probably some transpositions. Perfect reproduction of a series of this length normally requires repeated presentations. Some learning may be accomplished by one impression, but for larger masses of material repetition is essential for perfect re-establishment of the associated train in recital.

So far we have referred to reproduction immediately after learning. Where retention is desired for a longer period of time, further repetitions will be required to strengthen the associations in order to prevent their immediate dissolution. Ebbinghaus (7) demonstrated that even when an associative tendency is strong enough to bring about reproduction, it can be further strengthened by additional impressions, and that this further strengthening increases the durability and functional efficacy of the tendency. He found that it required 1,270 seconds to learn a series of sixteen nonsense syllables to the point of immediate recall. But when he read a like series eight times and then after twenty-four hours learned them to the point of immediate recall, he found that the learning took only 1,167 seconds. This meant a total saving of 103 seconds or an average saving of 12.9 seconds for each previous reading. Moreover, sixteen readings for learning after twenty-four hours saved a total of 192 seconds, or an average of twelve seconds for each reading. Twenty-four readings saved 295 seconds for the whole series, or 12.3 seconds per reading. Thirty-two readings were sufficient for immediate reproduction, but not adequate for retention over the twenty-four-hour period. The saving of time for relearning, however, continued to be proportional to the number of repetitions not only for thirty-two readings, but for forty-two, fifty-three, and sixty-four readings. Thus, it appears that each repetition provided approximately the same increment of learning, that the degree of learning increased gradually under repetition, and that repetitions beyond the point where perfect recital was possible continued to strengthen the associative tendencies to approximately the same extent as the repetitions which took place before the level of recall was reached.

Overlearning. This continuing to repeat after material is learned well enough for immediate perfect recital is called *overlearning*. It is essential wherever retention is to be maintained for any length of time, since forgetting sets in at once. School learning that is immediately forgotten falls short of its goal. Whatever is worth memorizing at all is worth learning well enough to be retained. How long the product of learning must be retained will depend on the purpose to be served by it, and the longer one must retain what he learns the more he will need to overlearn. Some learning serves a temporary purpose; for example, the memorizing of an oration for delivery at the graduation exercises or the lines of a play that will be given but once. Here we need only enough rehearsal or practice to insure adequate performance on these occasions. In the case of the combinations in arithmetic or the spelling of words in common use, a high degree of persistence is essential. To secure this there must be a great amount of repetition. Memory drills are for the purpose of fixing associations so that they will endure. They provide repetitions beyond the point of recall.

In chapter V it was pointed out that repetition is of itself not sufficient for learning and that the renewal of a function provides opportunity for improvement and fixation. This principle applies to memorizing. Repeated trials give the learner a chance to correct errors and to consolidate and stabilize his recital.

Distribution of repetitions. For best results the repetitions in memorizing should be distributed rather than massed. Massed learning means relatively long unbroken periods of work. To distribute learning means to spread the work out in time with several comparatively short periods. The greater effectiveness of distributed effort in memorizing has been amply demonstrated by many research studies. Several half-hour periods spent in memorizing, for example, will accomplish more than the same amount of time spent at one sitting. A few words in spelling each day for a week will be mastered better than a large number bunched in one lesson. This principle was first demonstrated experimentally by Ebbinghaus (1885). He found that lists of twelve nonsense syllables repeated only thirty-eight times, with the repetitions distributed over three days, seventeen on the first, twelve on the second, and nine on the third, were remembered better than similar lists repeated sixty-eight times at one sitting. Jost (21), working with lists of twelve nonsense syllables, concluded that two readings a day for twelve days were more effective than four readings a day for six days, and that the latter procedure was better than eight repetitions a day for three days. He also found that for learning such lists, ten repetitions a day for three days were superior to thirty repetitions at one time. Lyon (23) found that for learning lists of digits and nonsense syllables, one reading per day was much superior to continuous learning at one sitting; but for memorizing passages of prose and poetry he found little difference between the two methods. Bumstead (2), in more recent studies, has found distribution of learning more economical of time in memorizing prose and poetry. He memorized lines from Milton's *Paradise Lost* and passages from the Bible and compared results for intervals varying from zero to eight days. He concluded that for the longer intervals between study the actual time devoted to memorizing was shorter, while, of course, the total elapsed time from start to finish was longer. Other studies are in keeping with these findings.

The general conclusion that the distribution of learning is more economical than the massing of practice is adequately supported by the evidence on the subject. But just how long should the periods spent in memorizing be, and how long should the intervals between these periods be? The optimal length and spacing of the periods appears to depend upon the nature of the learning task and upon the age of the learner. It is safe to assume that in memorizing large blocks of material the learning should be spread over several periods, that for difficult material the periods should be shorter than for easy material, and that for young children there should be shorter periods than for older learners. In attempting to secure the advantages of distributed effort, we must guard against making the periods either too short or too long.

Reed (34) compared the gains made from sixty minutes spent in practicing addition of two-place numbers under four different procedures with respect to the distribution of the total time. One group worked for sixty minutes continuously. A second spent twenty minutes a day in practice for three days, a third group worked ten minutes a day for six days, while a fourth group practiced for periods of ten minutes twice a week for three weeks. His results indicated that the greatest gains were obtained from the twenty-minute periods once a day spread over three days.

Hahn and Thorndike (14) found that for a total of ninety minutes of practice in addition, 22½-minute periods brought greater gains than periods of 11¼ minutes for pupils in the seventh grade. For the sixth grade twenty-minute periods were equivalent to periods of ten minutes; in the fifth grade 7½-minute periods were almost as good as periods of fifteen minutes; and for fourth graders ten-minute periods were better than five-minute periods.

The effectiveness of the distribution of learning depends to a large extent upon what one does during the intervals. In a laboratory study in which 520 subjects were given the task of learning the names of thirty pictures, Eaton (6) used intervals of twenty, thirty, forty, fifty, and sixty seconds between the presentations of the items. He found that learning efficiency was greatest for the forty-second interval when the subjects rested during the intervals. Learning efficiency was reduced, however, when the intervals between presentations were filled with such activities as working out problems in arithmetic, checking letters of pied type, memorizing, or learning the names of other pictures. The greater the amount of attentive concentration demanded by these interpolated activities, the more was learning efficiency reduced.

Findings by Hovland (17) indicate that the rate of presentation is a factor which has something to do with the amount of superiority of distributed over massed practice. His subjects learned lists of twelve nonsense syllables by massed and by distributed practice under a two-second rate of syllable presentation and under a four-second rate. Under both rates distributed practice was superior as indicated by the number of trials required, but it was less superior for the four-second rate than for the two-second rate.

Several explanations have been offered for the superiority usually found in favor of distributed learning as compared with massed practice. The fatigue and boredom occasioned by long periods of memorizing are readily suggested. But this cannot explain the advantages of one reading over two at a single sitting, for two readings of a short list of words would hardly produce detrimental fatigue or loss of interest. It has been suggested that the advantage may be due to review by the learner during the intervals. Possibly this may happen in some cases, and a rehearsal during the interval between practice would aid, but this is not believed to be the true explanation, because even in the rat's learning of a maze the superiority of distributed practice has been found.

Jost (1897) concluded on the basis of his experiments and those of Ebbinghaus that older associations are strengthened more by repetition than new ones, and that of two associations of unlike age but of equal strength, the older one will be more resistant to the process of forgetting. Since forgetting takes place most rapidly right after learning, an old association that is as strong as one that has just been established will not be forgotten so quickly as the new one. Jost believed the advantages of distributing learning were due to the fact that the intervals between the learning periods gave the associations an opportunity to age.

Another explanation is found in the fact of "remote associations." It seems that in serial learning, associations are formed not only between the adjacent members of the series but between the nonadjacent members, forward and backward, as well. This was shown by Ebbinghaus and his findings have been verified by later studies (11, 16, 33). It is found that the more remote the items are from each other in the series the weaker will be the associations formed between them. The remote associations therefore tend to fade out sooner than the stronger ones between adjacent items. It is presumed that the advantages of distributed repetitions lie in part in the elimination of these indirect and useless associations during the interpolated intervals. Such associations might easily cause interference with the essential forward associations when repetitions are massed. This view is supported by the results of certain experiments that have shown little or no superiority for spaced learning over unspaced learning in memorizing of the paired-associates type, while for serial rote learning the superiority of spaced learning has been amply demonstrated (18). In the case of the paired-associates learning there is probably less opportunity for the formation of these remote or nonadjacent associations.

The length of the series and difficulty of learning. The relation of the difficulty of learning to the amount of material to be learned has been studied by a number of investigators. The findings have not agreed sufficiently to warrant a rigid generalization, but in most cases the results have indicated that as the length of the series of nonsense syllables increases, there is a relatively greater increase in the time and effort required for learning. This greater increase in difficulty as compared with the increase in the number of items to be learned is most marked as we pass from the memory span to lists exceeding the limit of organization for one impression. Ebbinghaus, for example, was able to recite seven nonsense syllables after one reading, but seventeen readings were required for learning a list of twelve, and thirty readings were necessary to master a sixteen-syllable list. As the number of syllables of the list was increased, there was an increase in the number of readings per syllable. Similar results are reported by Binet, Henri (1), Lyon (23), and others. When difficulty is judged in terms of the amount of time required per item, a similar disproportionate increase is usually found.

Some of the data indicate a gradual lessening of the degree to which the increase in difficulty surpasses the increase in the size of the list as we pass to relatively longer lists and get farther away from the region of the memory span. In a few cases where the increase is made in a comparatively long list, the increase in difficulty appears to be relatively less than the increase in the size of the list. An example of this is seen in the experiment by Ebbinghaus in which forty-four readings were required to learn a list of twenty-four syllables, while fifty-five readings were sufficient to learn a list of thirty-six. Here an increase of fifty per cent in the length of the list was accompanied by an increase of twenty-five per cent in the required number of readings. Robinson and Heron (37) found for nonsense syllables that while the number of repetitions per syllable increased as the length of the list was increased, the extent to which the increase in difficulty exceeded the increase in length was less with increases in the relatively longer lists than for increases in the shorter lists. They also found that the shorter lists were forgotten more rapidly than the longer ones. Similar results were obtained by Robinson and Darrow (36) in a later experiment on memorizing lists of four, six, eight, and ten three-place numbers.

This problem is complicated by other factors besides the magnitude of the lists compared. The increase in difficulty with an increase in the amount of material to be learned is apparently influenced by the kind of material and by the distribution of practice. Lyon's study indicated that while for continuous learning at one sitting the time required for memorizing digits and nonsense syllables increased at a proportionately faster rate than the length of the series, for one reading per day (distributed learning) the increase in time corresponded roughly to the increase in the series. Henmon (15) reports that for memorizing poetry the number of repetitions increased proportionately less than the increase in the number of lines or stanzas. Greater economy for the longer passages was also indicated by the greater saving found for them in relearning after twenty-four hours. This difference in retention in favor of the longer selection was relatively greater for poetry than for nonsense syllables. For prose the number of repetitions remained approximately constant for passages of different lengths. Prose passages of 100, 200, and 300 words required an average of 6.1, 7.3, and seven repetitions respectively.

Cofer (3) compared the time and trials required to reach mastery of prose passages of different lengths for both verbatim and logical learning. For logical learning the learner had only to master the essential ideas of the passage. It was found that verbatim learning not only required more time and repetitions than logical learning, but that it was also more affected by increases in the length of the passages. With increases in the amount of material to be learned difficulty increased at a greater rate for verbatim than for logical learning.

To explain the disproportionate increase in difficulty of learning with an increase in the amount of material to be learned some writers have suggested that it may be due to the greater fatigue effects and needless repetitions of parts already learned in memorizing the longer lists. The most satisfactory explanation seems to be that in the longer lists there is more interference between the members within the series due to remote associations. This view is in keeping with the findings of better retention for the longer series, because the remote associations drop out or are forgotten more quickly than the associations between adjacent members, and hence they would offer less interference at the time of recall than at the time of learning.

Position in a series. It is well known that the first of a series of experiences is likely to have high memory value. As a rule, we easily recall our first day of teaching, our first visit to a particular city, and our first airplane ride after we have forgotten later ones. In memorizing, the beginning and the end of a series are usually learned before the middle part.

In an experiment, three series of fifteen items were presented once to a group of sixty-eight students. The first series consisted of nonsense syllables; the second, of unrelated words; the third, of related words. The number of correct reproductions for each item in the three series is shown in the following table:

Serial position of item:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Nonsense syllables	56	35	24	22	24	8	12	9	6	3	7	3	18	26	51
Unrelated words	65	68	45	37	58	18	44	32	36	15	46	31	49	49	58
Related words	66	68	67	54	67	58	59	58	58	56	52	52	62	52	62

It will be noted that the first and the last nonsense syllables were reproduced with far greater frequency than the others in the series. A similar trend is found in the two meaningful series, although to a less degree.

It is probable that the effect of primacy and finality varies for different learning and testing methods (32). Where the learner can glance back or review the early items during the presentation of the series, the added frequency for these items might account in part for the primacy effects. There is for the first item in most experimental situations an expectant attitude and alert attention, which is conducive to a good impression, while later items suffer from the interference occasioned by the crowding or piling up of impressions. Novelty, zest, and freedom from interference by preceding impressions favor first impressions, and lack of interference by succeeding impressions favors the final impressions.

Rhythm. Rhythmical reading with its recurring accent, as seen in the common singsong method of memorizing poetry, tends to produce a closer cohesion of elements within the units of the rhythm pattern. This closer integration of items within the rhythmical unit as compared with those belonging to different units was demonstrated experimentally by Müller and Schumann (26). There is some evidence that rhythmizing may tend to form relatively strong backward associations. But, on the whole, through its facilitating effect on unit organization within larger units of memory material, the effect of rhythm may be considered more helpful than detrimental.

The learner's set. The intent to learn is an important factor for successful memorizing. While it is true that associations are formed in many cases without intent to learn, little progress in mastering the memory material of the school situation may be expected from mere exposure to that material. A teacher may read a poem to children several times for the purpose of having them learn it verbatim and find that he cannot recite it himself after the children are able to do so. In giving an intelligence test we tell the child to listen carefully while we read a passage so that he will be able to tell what it says. The child listens with the intent to remember what he hears. As examiner, having no such purpose, we do not retain what we read and are a bit shocked to realize that the child is reproducing the content far better than we could.

The influence of the learner's *task* or goal-set on his learning has been demonstrated in the following manner. A series of ten cards, each bearing a word and a number, was presented eight times to a group of ten students. Below the number on each card was a strip of colored paper, the color being different for each card. The students were instructed to observe carefully, as the cards were presented, the word on each card and the number which appeared with it, so that they would be able to reproduce the words together with the correct number for each. Nothing was said about the colors. Following each presentation of the whole ten cards the students were asked to write down as many of the word-number pairs as they could recall. After the series had been presented eight times, they were asked to name the color which was presented with each word. The means of the reproductions for the eight trials were as follows:

Trials:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Word-number pairs	3.7	5.6	7.0	7.2	8.3	8.7	8.8	9.7
Word-color pairs . . .	—	—	—	—	—	—	—	2.9

It will be seen that more word-number pairs were recalled after one presentation than word-color pairs after eight presentations. After the eighth presentation all but one of the group gave correctly all ten word-number pairs. The one who had not reached complete learning reproduced seven correctly. Yet the mean number of word-color pairs reproduced was only 2.9. When allowance for successful guessing is made, it is evident that there was very little learning of the word-color combinations.

Another and more general form of set which affects the learning process in a vital way is the *attitude* of the learner. Lack of confidence in ability to memorize, dislike for such work, dislike for the teacher or the school in general, feelings of distrust for the teacher, unwillingness to coöperate, antagonisms, the feeling that there is no sense or value in learning the material are some of the attitudes which may affect unfavorably the child's efforts to learn. For best results there is needed a spirit of coöperation between pupil and teacher, confidence in ability to learn born of past successes, and the feeling that the ability to recite this particular material will be definitely worth while. The teacher should strive to secure the eager and active kind of attitude that comes from a real desire to learn.

Attention. An indispensable condition for successful memorizing is *attention.* It is well known that unusually vivid and novel impressions have strong memory value. The heightened attention which attends such impressions is probably the main reason. It is also well known that one does not remember things to which he fails to give attention. The securing of adequate attention on the part of the learner is an essential feature of accepted laboratory techniques. In experiments on learning, lapses of attention or serious distraction during the presentation of a series of items to be learned would be due cause for considering the results invalid. If the presentation goes forward continuously, as in the case of a teacher's reading the lines to be learned, any wandering of attention means breaks and gaps in the learner's perceptual train. When the learner reads from a book by himself, after a lapse of attention or distraction, he may come back again to the point where the train was interrupted and go on from there. Still here there has been a break with the intrusion of extraneous impressions, which impairs the effectiveness of his learning. Without the sustaining effect of interest the child's attention is likely to shift readily from the task at hand. He is easily distracted. It behooves the teacher, therefore, to secure adequate interest in the material and to prevent so far as possible all distracting influences. Negative adaptation should be developed for unavoidable noises or other factors to which children are prone to shift their attention. Since fatigue is inimical to attention, a child should not be required to memorize for long periods of time. Memory drills and exercises should be short.

Meaning. Every teacher should have the experience of memorizing nonsense syllables so that he can appreciate what it means to children to be required to memorize material that has no meaning for them. Experimental evidence clearly indicates the greater ease and facility for memorizing meaningful as compared with meaningless material. Being meaningful means that there has been some previous experience with the material and that some associations have been formed with it. In other words, meaningful material is already learned to some extent. It was for this reason that Ebbinghaus devised and used nonsense syllables in his experiments. He wanted to avoid the uncontrolled variables of previous experience in the interest of more reliable quantitative measures of associative learning.

The importance of meaning for the formation of new associations is revealed by comparing the learning of a list of nonsense syllables and a list of familiar words. In an experiment by the writer, two lists of twenty nonsense syllables and two lists of twenty sense words were presented to a group of forty-seven students. The nonsense syllables were of the usual form, two consonants with a vowel between, such as *var, mup, tib, sov.* The sense words were all of the same pattern. Some examples of them are: *won, tan, dog, law.* The four lists were presented in the following order: first, nonsense; second, sense; third, sense; fourth, nonsense. This was done to distribute the factors of practice and fatigue equally for the two types of material. The subjects were instructed to read the terms silently and attentively as the experimenter exposed them one by one at the rate of one per second. After each list was presented, the subjects wrote down as many items from the series as they could recall. The mean number of words or syllables reproduced by this group for each of the four series was as follows:

I.	Nonsense syllables	6.8
II.	Sense words	14.2
III.	Sense words	13.9
IV.	Nonsense syllables	8.3

For series I and IV combined the mean number of syllables recalled was 7.5, and for series II and III the mean number of words recalled was fourteen.

In another experiment, three lists differing in meaning were presented to 348 students. The first series consisted of fifteen nonsense syllables, the second was a list of fifteen three-letter sense words, and the third contained fifteen words meaningfully related to each other. These items were presented one by one on large cards at the rate of one every two seconds. After a single reading, reproductions were made in writing. The mean number of correct reproductions for each of the three series was:

I.	Nonsense syllables	4.47
II.	Unrelated words	9.95
III.	Logically related words	13.55

In the experiments just cited the series were presented only once. Hence, learning was incomplete. The measure of the degree of learning for purposes of comparison was made in terms of the number of members reproduced. Similar differences between meaningful and non-meaningful materials can be demonstrated by the method of complete mastery. Here the subject continues to repeat each series until he can recite it correctly. Learning is measured in terms of the time or the number of repetitions required to reach complete mastery. For the same three lists used in the experiment just described, Guilford (13) reports the following as the mean number of trials required for complete mastery by 117 subjects:

I.	15 nonsense syllables	20.4 trials
II.	15 unrelated words	8.1 trials
III.	15 related words	3.5 trials

It should be remembered, moreover, that there is a rather wide range of individual differences in the case of all of the measures of learning mentioned here.

There is probably very little learning without meaning. Even in learning nonsense syllables, the learner finds various ways of making meaningful associations, and it is very difficult to avoid doing so. Sometimes these associations, which afford a meaningful grip on the syllables, are found between the members of a series, and often they involve bringing in something from the outside. The learner may observe that *muh* and *kuh* are alike except for the first letter, and that they rhyme; that *kef* was encountered in another series; or that *cug* is the same as *guc* backwards. In many cases the syllables take on meaning because they are seen as the first part of a familiar word; or the subject adds a syllable (inclusion), and thereby attains a satisfying meaning, which aids learning. Often the letters of a syllable become meaningful initials, a word spelled backwards, or the makeshift substitute for a familiar word.

When one is memorizing lists of unrelated sense words, the words themselves are already meaningful units. The learner therefore does not find it necessary to resort to the devices used to make nonsense syllables take on meaning. The clever learner here builds up meaningful connections between the various words. This integrates the members of the series into larger units, and the more closely they are integrated in learning the surer will recall run on from one member to the next. One subject, for example, tied together the words *pet, son, cat,* and *box,* by making the sentence, "The *son* put his *pet cat* in the *box.*" A few constructed a story, which tied together in a meaningful unit a large number of the words. Such relations of belonging together greatly facilitate this kind of learning.

In the series of logically related words all the words of the list were names of parts of the human body. They started at the head and proceeded downward to the toes. Here the relations between the words, which had to be devised by the learner for the lists of unrelated words, were ready-made. The effect of these relations on learning is revealed by the consistently larger score for lists of this type. Sometimes in reproducing these lists the subject inserted a term that was not presented in the learning series because it was associated with some of the presented items in previous experiences. For example, in the list of names of parts of the body the words *hip, wrist,* and *elbow* were not included, but these words were often added to the words reproduced.

The practical importance of the influence of meaning on memorizing is indicated. No pupil should be asked to memorize something he does not understand or in which he is unable to find meaning. All memory material should be made as meaningful for the child as possible. Number experiences should precede the learning of the combinations in addition and subtraction. A child should know definitely what words mean before attempting to learn their spelling. Poems should be thoroughly comprehended before one undertakes to learn them verbatim. Dates and names of persons and places should not be memorized as isolated bits of information but should be incorporated into larger units of understanding.

In order to meet these requirements for economy in memorizing, the teacher should seek to widen the child's range of associated experiences. Particularly should the material to be learned be related to his own needs, welfare, and interests. This may be accomplished in various ways, by discussion, by explanations, and by stories of related events. Questions are useful in bringing the child's former experiences into relation with the new material. Meaningful organization may be promoted by a consideration of likeness and differences, the bearing of one fact upon another, group membership, and the answers to such questions as "Who were involved?" "When did this incident take place?" "Where did it take place?" "What were the causes?" and "What were the consequences?"

Whole and part learning. Considerable attention has been given in the literature on learning to the relative efficiency of memorizing by parts or by the *whole method*. By the whole method one reads and rereads the entire block of material to be learned, be it a list of terms, a selection of prose, or a poem, and continues until the whole block can be recited. By the *part method* the material is learned one section at a time. The learner takes not the whole but a part of the list or a stanza of the poem and completely learns it. Then he takes up the next section and studies it until he can recite it. Then the third division is learned, and so on from part to part until each of the divisions has been mastered.

The results of the experimental studies on the relative merits of these two procedures have not established the forthright superiority of either method for learning under all types of conditions. Some studies have found the whole method better, others have obtained better results by the part method, while a number have found no clear-cut difference between them. The weight of the evidence and competent opinion seems to favor the whole method, but studies favoring the part method reveal that under some conditions the whole method is not superior to nor as good as the part method.

A comparatively recent study by Jensen and Lemaire (19), including ten experiments on this problem, found that the whole method was superior to the part method in six experiments. For memorizing chemical information one group did better with the whole method, another did better with the part method. With some other materials the part method was found slightly but not significantly better than the whole for one group. The report on these experiments claims that 34.3 per cent of 504 children learned better by one or the other of the two methods, and that of these, 17.2 per cent did better with the whole method, while 17.2 per cent learned better by the part method. These children did not always do better by the method which was habitual with them. For about a third of them their habitual method proved to be less effective in the experiments. The suggestion made here is that a child left to his own selection cannot be depended upon to choose the method which for him will be more effective, and that the method more effective for one child will not necessarily be superior for other children.

The general advantage of the whole method lies in the fact that from the start it puts the items to be associated in their proper order, and binds them together in the sequence needed for correct recital. It utilizes the consolidating values of meaning for the whole selection and this favors good retention. The part method consolidates the section of the whole. After the parts have been learned, additional learning by the whole method is necessary in order to tie the parts together. This involves additional repetitions, which are not necessary when all the parts are learned together in the first place.

Some experiments indicate that *practice* with the whole method is necessary before some persons can do better with it than with the part method. Steffens (44), who found that the whole method required less time for learning poetry and syllable lists, observed that the advantages of the whole method sometimes did not appear at first and showed up only after the learner had become accustomed to using this procedure. Lakenan (22) found that while at first better results were obtained from the part method, later on, after practice, the whole method proved to be more effective.

There is no doubt that the *attitude* of the learner toward the whole method is an important factor in determining how well it works. Children often prefer the part method, and unpracticed adults are often skeptical of the advantages of the whole method. With the whole method much more time and work is required before any results of learning are manifest. One may read a long poem through a dozen times without being able to recite a single line, while with the same amount of work by the part method the learner would probably be able to recite several stanzas. For this reason a learner gets the feeling of success sooner with the part method. The recitation of parts become sub-goals, which provide a series of steps toward the main goal, the ability to recite the whole. These intermediate goals and the satisfactions derived from reaching them no doubt favor the part method, particularly with children and with adults unaccustomed to rote memory work. The whole method is likely to be discouraging because the learner has to work so long before he can see any returns for his effort. He may feel that he is not making any progress or that he is wasting his time with this "new-fangled method." This attitude operates against the success of the method. The experienced and informed learner knows that the readings in the whole method are not a waste of time. He knows, as Ebbinghaus demonstrated, that every reading yields an increment of learning, which is spread over the whole, and that if he continues, he will eventually find the whole selection rising above the threshold of recall. He knows that while he must work longer before results are manifest, the final returns fully justify his patience and endurance.

Another factor, which must be taken into account in considering the relative merits of the whole and part methods, is the *length of the material* to be memorized. It is quite obvious that a selection may be altogether too long to be handled adequately by the whole method. It would seem that any selection requiring more than ten or fifteen minutes to read would not be suited to memorizing by the strictly whole method. The experimental evidence on this point is scarce. Pyle and Snyder (31) report experimental work with one subject in which the whole method proved superior in memorizing selections of poetry up to 240 lines in length. Very long selections are likely to involve fatigue and a relaxing of attention, which would tend to cancel any advantages the method might otherwise have.

Finally, the *character of the material* itself has much to do with the relative advantages of these two methods. The superiority of the whole method depends largely upon how compact a meaningful unit the entire selection is. If it is not too long and the material is closely knit together on one theme, the whole method will probably bring better results. Studies by Northway with school children, for example, indicated that for memorizing poems the whole method is advantageous for poems understood as a whole (28). When the parts themselves are more closely integrated than is the whole selection, we may expect the part method to be superior (39, 40).

It appears, therefore, that under the right conditions the superiority of the whole method can hardly be questioned. In actual practice, however, we seldom have together all the conditions that make this method superior to the part method. For best results in memorizing, a combination of the two methods, which will avoid most of the disadvantages of both and at the same time secure as far as possible the advantages of both, is to be recommended. In one form of such a combination of the two procedures the learner first reads the selection through entirely several times to get the thought of the whole clearly established. Then the selection is divided into suitable parts and learned by the part method. Finally, the whole is reviewed to secure adequate organization of the parts into the total associative train. This procedure is regarded as desirable for offsetting the principal drawbacks to the whole method.

Another procedure, which combines some of the features of the part and whole methods, is known as the *progressive part method*. By this procedure a poem would be learned in the following order. First the initial stanza is memorized, then the second. Next the first and second are reviewed together. Then the third stanza is learned. This is followed by a review of the first three stanzas together, and so on, with a review, after each new stanza is added, of all that have been learned. After the final stanza is memorized comes a review of the whole poem. It would seem that a drawback to this method would be the unnecessary repetitions of the early parts. It was found to be somewhat better than either the regular part or whole method in a study by Reed (35). In his experiments, Reed had students learn selections of poetry, using a different method for each of three sections of four stanzas. The average time required for the whole method was 5.95 minutes, for the part method 5.45 minutes, and for the progressive part method 5.21 minutes. The best time was made by fifty-six students with the progressive part method, as against thirty-one who did best with the part method, and twenty-six who did best with the whole method. Stroud and Ridgeway (47) in comparing these three procedures for memorizing poetry found that the whole method required more trials than the other two methods. The differences between the time scores for the three methods were small and lacked reliability. Relearning scores obtained one week after the first learning indicated little difference between these methods for retention.

Recitation during learning. It has been reliably demonstrated that reading combined with recitation is superior to reading alone for memorizing both meaningful and non-meaningful material. This combining of reading with recitation is known as the *recitation method.* In practice it means that after a few readings or presentations the learner attempts to recite the material without looking at it. When he is unable to proceed, he refers to the printed material again to prompt himself. Then he continues reciting what he can, glancing at the book or lists only when necessary. A number of experiments have indicated the advantages of such a procedure.

One of the most widely quoted studies on this subject was made some years ago by Gates (12). He had children and college students memorize nonsense syllables and biographical material. The time devoted to study was divided for different groups so that different amounts were devoted respectively to reading and recitation. The material to be learned was printed on a sheet of paper. This each subject read until he was given a signal to recite. Then he began reciting to himself and referred to the paper whenever necessary. It was found that for the nonsense material the amount reproduced was much greater for reading with recitation than for reading alone, that the difference increased as the proportion of time devoted to recitation was increased, and that it was greater for delayed recall than for immediate recall. The difference was not so marked for the meaningful material, although it was sufficient to indicate the value of recitation in memorizing.

Similar results were obtained from a study on this problem by Forlano (9). His subjects, children in the fifth and sixth grades, learned spelling, arithmetical facts, and vocabulary material under normal school conditions, by the recitation method and by reading without recitation. The recitation method was found to be superior to the all-reading method in each of the experiments for both immediate and delayed recall. The superiority of the recitation method was generally greater for delayed recall than for immediate recall. In the case of spelling with one fifth and two fifths of the time devoted to recitation the results were only slightly better than for reading only. But with three fifths of the time spent in recitation the superiority over all reading was significant and only slightly less than for putting in four fifths of the time reciting.

Granting the superiority of the recitation method over the all-reading method, Skaggs (42) devised an experiment to discover the relative value of grouped and interspersed recitations. After two preliminary readings of a selection of poetry his subjects, college students, tried four different procedures with regard to reading and recitation. According to the results of this experiment it is better to have one recitation or attempted recitation after each reading than to have the readings and recitations grouped by twos or threes.

The practice of attempting to recall during the course of learning is conducive to an active attitude, vigorous effort, and concentrated attention; but perhaps the most important reason for its superiority over the all-reading method is that the individual actually practices what he is trying to learn. Just as we learn to write by writing, so to learn to recite one should practice reciting. This means the development of the functional trends for which the learning is intended. It gives the learner an immediate goal, shows him the progress he is making, and reveals the imperfections in his performance that need to be remedied. After a few readings nearly everyone tries to test himself in some way. This was found to be true more or less in the experiments using the all-reading method.

A practical question arises about when the reading-recitation process should be started. This naturally will vary with different types and lengths of material. Except for very short selections it will first be necessary to read at least a few times without recitations. Four to eight times has been suggested as optimal for relatively short materials (43). Recitation must not be guessing (10). Attempts to recite too soon waste time and may lead to troublesome errors.

The influence of affective toning. Among the experiences most easily recalled are those emotionally toned or markedly pleasant or unpleasant (4). The question arises regarding what influence the affective qualities may have upon learning. Experimentation on this problem is difficult, for one can never be sure what feeling-tone may be aroused by a particular situation, nor can one assume that material pleasant for one subject may not be indifferent or unpleasant for another. There is always need for report on this feature of the experience by the subject himself.

Metzner (25) undertook to determine whether there would be a difference between the efficiency of learning in a pleasant feeling state and in an unpleasant feeling state. The materials, which consisted of nonsense syllables, a list of meaningful words, and a meaningful passage, were presumably indifferent. The unpleasant state was produced prior to the actual test by the experimenter's disagreeable manner, carping remarks, petty criticism, a bitter drink, foul odor, disturbing noises, a difficult preliminary test, and a small, poorly lighted experimental room. The pleasant state was secured by a genial attitude on the part of the experimenter, friendly conversation, a cooling drink, a simple test, which indicated a good showing for the subject, and a spacious, well-lighted, and well-ventilated room. The reports of the subjects indicated that the feeling states corresponded to the conditions of the experiment, except for about half of the males, who did not find the conditions intended as offensive to be unpleasant. The results indicated no significant differences for efficiency in learning under the pleasant state and the unpleasant state. The subjects in this experiment were, however, college students, and because of their greater maturity and emotional stability it may well be that for them learning is less affected by feeling states than for children.

Regarding the material itself, it appears that affectively toned materials tend to make a more lasting impression than indifferent material. In an experiment by White and Ratliff (50) college students learned a list of pleasantly toned words, such as *flower, smile,* and *home,* and a list of unpleasantly toned words, such as *vomit, disgrace,* and *insult.* After complete learning the two kinds of words were recalled about equally well in a test given shortly after learning and after one week. The recall of the pleasant words, however, was slightly better after two weeks. Immediate recall after one reading of lists of fifteen words was slightly better for the pleasant words.

In another experiment (41) a list of 117 words was given to each of seventy-three subjects. The subjects first rated each word as pleasant, unpleasant, or indifferent. Then after a five-minute period of rest and distraction they were asked to write down as many of these words as they could recall. The averages for the recall test were: pleasant, 21 per cent; unpleasant, 17.9 per cent; indifferent, 14.2 per cent.

In general, the studies on this problem indicate that retention is best for materials that are pleasantly toned, and better for unpleasant materials than for indifferent materials.

Mode of impression. There are several different possible modes of impression in memorizing. If it is a poem to be learned, for example, it may be read to the child while he listens, the printed poem may be given to him to read silently or aloud, he may write it down as he hears or reads it, or he may read it aloud in concert with other children. These and other possible variations, it will be noted, make use of different sense impressions and different combinations of sense impressions. Here we have another variable in the complex of conditions affecting the efficiency of memorizing. Our concern is with the relative effectiveness of the various modes. It seems to depend upon the individual learner what particular method is best. Some persons seem to learn better by hearing, others by seeing, and others by combinations of seeing, hearing, and responding verbally. At present we cannot say that any one method is best for all. Even the method best for one person for learning one kind of material may not be the best method for him for learning other kinds of material. The practical course for the best interests of all when dealing with a number of children would be to use different modes of impression and procedures in order to bring into play different senses and various combinations of the senses.

In a laboratory exercise on the memory span for digits the writer has frequently used four different methods in presenting the series of digits. The first is the *auditory* method. Here the digits are read by the experimenter. The subjects listen attentively, and after each series is read, they write it down, if they can, in correct order. Series varying from four to thirteen digits in length are read. The number of digits in the longest series correctly reproduced is taken as the measure of the memory span. The second is the *visual* method. Here a similar set of digit series is printed on strips of cardboard, one series to a card. The cards are held up before the subjects, who read silently and try to reproduce the series after the card is removed. The third is called the *visual-auditory-vocomotor* method. The digit series, printed on cards, are presented visually as in the second procedure, but instead of reading silently the subjects read aloud in concert. The impression involves seeing, hearing, and the verbal reaction. For the fourth method, called *auditory-manumotor-visual,* the experimenter reads the digits, and as he reads the subjects write them down. After each series is written in this way the subjects turn over their papers and write their reproductions. Here we have the auditory impression from hearing, the kinesthetic impression from writing, and the visual impression from seeing the results of the writing. The following is a typical set of scores from a group of thirteen students:

Student	*Visual*	*Auditory*	*Visual-Auditory-Vocomotor*	*Auditory-Manumotor-Visual*
1.	9	10	10	10
2.	7	7	8	8
3.	7	7	7	7
4.	9	8	9	8
5.	9	9	11	9
6.	9	10	11	9
7.	9	10	12	9
8.	7	9	8	8
9.	6	7	7	7
10.	7	6	6	7
11.	9	11	12	8
12.	8	9	9	8
13.	8	8	8	8
Total	104	111	118	106
Means	8.0	8.5	9.1	8.1

It will be noted that the subjects who made the better scores with one mode of impression usually made the better scores with the other modes, that for some there is little or no difference in the scores for the different modes, and that some do better with one mode than with the others. While no one mode is best for all, the group average for the third method has nearly always been the highest.

A study of the relative effectiveness of twelve different modes of presentation has been made by O'Brien (29). His subjects learned nonsense syllables and meaningful words. While his results showed that no one mode was best for all, the group averages were distinctly in favor of the reading-aloud procedure, which combines visual, auditory, and vocomotor impressions.

The question of whether children learn poetry better by reading aloud in concert or by silent reading was put to an experimental test by Dumville and Lewis (5). Two classes were each divided into two sections of equal ability as determined by a preliminary test in memorizing. One section memorized silently while the other repeated the stanzas aloud simultaneously. The younger class (average age, ten years) was given ten minutes for learning. The older class (average age, twelve years) was allowed eight minutes. When the time was up, the pupils were instructed to write as much of the poem as they could. It was found that the majority of the pupils learned better by the silent method. The concert method was better for some. In general, the younger and more backward children were favored by the concerted repetition.

Winch (51, 52) conducted experiments on learning to spell for the purpose of finding out whether silent study or spelling aloud in concert with the rest of the class would produce better results. The subjects were young, poorly privileged boys from a municipal elementary school in the East End of London. Two lists of words of approximately equal difficulty were learned, one by the silent method, the other by spelling aloud in concert under the direction of the Head Master. For these boys the concert method proved to be slightly better than silent study. But when the same methods were tested with older and mentally more proficient girls, the results were reversed. For the more advanced and more fortunately placed girls the silent method was superior. Winch believed that it was the difference in mental ability which was responsible for the difference in the relative effectiveness of these two procedures for the two groups studied. Concerted oral repetition may be a help to the young and backward pupil, while the silent method seems better for the brighter and more mature student who has no difficulties with reading and who is habituated to individual silent work. Winch points out that since most learning must be done silently and alone, the school should train children to learn efficiently by the silent, visual method.

An experimental study was made by Russell (38) to determine whether pupils will learn better by having the material read to them by the teacher or by their own silent reading of the materials. Over 600 pupils from grades V, VII, and IX took part in the experiment. Three procedures were employed with groups equated for ability by means of an intelligence test. In the first procedure the teacher read the material to the group twice. In the second the members of the group were handed the material and told to read it at their normal rate. The time allowed them was the same as that used by the teacher for two readings. In the third procedure the pupils were told to read the material twice at their normal rate. The second method kept the time the same as the first, while the third kept the number of readings the same, regardless of time. The results differed for the three grades. In the fifth grade the children learned more from having the material read to them. For the seventh grade the two procedures were about equally effective. For the ninth graders the reading method proved to be somewhat superior. It appears, therefore, that the relative efficiency of learning by hearing and learning by reading is dependent upon the factors of maturity and training.

Individual Differences

The individual members of any group working under the same methods and with the same material will vary considerably in the rate of learning. For example, when a list of twenty monosyllabic words was presented seven times to a group of forty-eight students who were asked to reproduce after each presentation, the range of the scores (words recalled) and number of subjects reaching complete mastery for each trial were as follows:

Trials:	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Range of scores	4-14	8-18	13-20	13-20	15-20	14-20	14-20
No. reaching complete mastery	0	0	4	5	10	6	7

One third of the group failed to learn completely in the seven trials.

After a single presentation of fifteen nonsense syllables, fifteen unrelated words, and fifteen related words to a group of sixty-eight students the range of the scores for immediate recall was: nonsense syllables, 1-10; unrelated words, 6-13; related words, 10-15. In any sizable group of learners in the laboratory or in the classroom we may expect to find relatively fast learners and relatively slow learners. Under the same conditions of instruction, method, amount and kind of material to be learned, the individual members of a group will differ rather widely in the amount learned in a given time, or in the number of repetitions and time required for complete mastery.

It is sometimes believed that the fast learner does not remember what he learns so well as the slow learner. This assumption is not borne out by careful observation. The opposite is more often true. The fast learner is usually the more efficient learner, and as a rule his retention is better than that of the slow learner. This is probably due to the factor of intelligence, for both rate of learning and retention correlate highly with the mental age (24, 27, 30).

Age differences. The rather popular notion that childhood is the golden age for memorizing is contrary to the findings of systematic investigations of age differences in ability to learn. The evidence from many studies shows that the ability to memorize increases from its earliest manifestation in the young child to the late 'teens or early twenties.

The age norms of the Revised Stanford-Binet Tests of Intelligence for the number of digits to be repeated after one hearing is a good indication of the increase of memory ability with age up to maturity. With the standard in each case being one correct repetition in three trials, the child at 2½ years repeats two digits; at three years he repeats three digits; at 4½ years, four digits; at seven years, five; and at ten years he repeats six; while the superior adult repeats eight or nine. The sentences to be repeated as memory tests are longer in the upper age levels than for the earlier years, and the standard is higher for passing the memory-for-designs test in year XI than for year IX.

When children of various ages are given the same learning tasks, the older ones learn in fewer trials and retain better than the younger ones. In a study by Stroud and Maul (46) 226 subjects ranging in age from seven to eighteen years learned lists of nonsense syllables for ten minutes and selections of poetry for fifteen minutes. The learning was measured in terms of the number of syllables and lines of poetry learned within the time limits. The results in averages for the various groups were:

Average Age	*Lines of Poetry*	*Nonsense Syllables*
7.7	9.71	4.73
8.5	11.16	5.12
9.4	13.15	5.82
10.4	16.02	6.43
11.7	17.55	6.47
14.4	21.31	7.39
18.1	22.14	8.71

A regular increase in scores for both kinds of material accompanied the increase in age through the range studied.

Thorndike (48) reports several experiments on adult learning which show that learning ability in childhood is inferior in many respects to learning ability in the twenties and thirties. Studies on learning Esperanto indicate an increase in ability from age eight to twenty or later, with a continuance of the high level until about twenty-five or later. Then there is a slight decline to about age thirty-five, followed by a decrease to forty-five and after (48*a*). Thorndike estimates that the ability to learn Esperanto drops about twenty-two per cent between the ages of twenty-two and forty-two (48*b*).

It has frequently been stated that childhood is the ideal time for education because the child's mind is more plastic than the adult's. Since the child's habits and ways of thinking are not so fixed as the adult's, it was assumed that he could be more easily trained along desired lines. Thorndike (48*c*), commenting on this point, writes:

> . . . If there were nothing in favor of early schooling save the greater mental plasticity of the youth, in the sense of youth's ability to learn, we might better replace "Childhood is the time for learning" by "The time for learning anything is the time when you need it." For there are great advantages which accrue when learning satisfies some real need, benefits some cherished purpose, and is made use of at once and so kept alive and healthy for further use.

Intelligence. Differences in learning ability related to age and intelligence were suggested by the experiments made by Winch (51, 52) cited above. When Stroud and Maul (46) compared their data for children having the same mental age but different chronological ages, they found no correspondence between scores and C.A. For children of the same C.A. and different I.Q.'s those having the higher I.Q.'s tended to make the better scores. This tendency was less decisive for nonsense syllables than for poetry. This and other evidence indicate that the learning ability is closely related to the M.A. Two children whose C.A.'s are eight and twelve, both having an M.A. of ten, will probably be more alike in learning ability than two ten-year-olds with M.A.'s of eight and twelve respectively.

An experimental comparison of the learning of high-grade defectives and normal children has been reported by Fildes (8). Her subjects were fifty mentally defective boys of the Littleton House School in Cambridge, England, and groups of normal children for comparison. She presented to the subjects eight simple forms with nonsense words or names. The form was presented for five seconds. Its name was spoken by the experimenter and repeated by the subject three times in each trial. Then the form was presented and the child gave the name; or the name was spoken by the experimenter and the child drew the form. This procedure was continued for twenty-four trials except in cases where the child succeeded in learning all eight forms in fewer trials. The averages for the number of repetitions required for learning by thirty mentally deficient boys and by twenty-five normal boys are shown in the following table:

	30 Mentally Deficient	*25 Mentally Deficient*	*25 Normal Boys*
Average age	12-3	13-0	11-1
Age range	7-2 to 15-11	10 to 15-11	10 to 12
Average no. of repetitions for learning	13.3	11.4	5.64

The group of twenty-five defective boys shown in the table of results represents the omission from the first group of the five youngest, who were under ten years, in order to make the youngest defectives in the group as old as the youngest normal child. It will be seen that the mentally deficient boys required more than twice as many trials to learn as did the normal boys, whose average age was less. The mentally deficient boys were more variable than the normal boys, as shown by the fact that the number of trials required by the former ranged from five to twenty-four, while the trial range for the normal group was two to nine. The defectives made more errors and were slower in correcting them. They had less ability to criticize their own results and were slower in adapting themselves to new methods of learning.

The mentally superior child learns faster than the mentally less gifted. He is able to keep his attention on his work better and makes adjustments more easily to new conditions of study. He is handicapped if his learning is paced at a rate suited to the child of average intelligence. Instruction should be adapted to differences in mental ability.

Sex differences. It is frequently stated that girls surpass boys in ability to memorize. Jordan (20), for example, writes that only forty per cent of the boys do as well as or better than the median for girls in memory for words. On the other hand Stroud (45) cites a study in which no sex differences were found for memorizing nonsense syllables and poetry. For reproduction after one presentation of a list of fifteen nonsense syllables, a list of fifteen unrelated monosyllabic words, and a list of fifteen related words, the writer obtained the following averages for five groups of students making up a total of 106 men and 161 women:

	Nonsense Syllables	*Unrelated Words*	*Related Words*
106 men	4.36	9.94	13.63
161 women	4.34	10.09	13.08

It will be noted that there is practically no difference between the scores for the men and women. There were larger differences between the various group averages for the men and between the various group averages for the women than appears here between men and women in the combined averages. These data are based on one impression, and the learning is incomplete. They do not speak for complete mastery or for learning under other conditions. The results obtained from various comparisons of boys and girls do not agree. Sometimes boys are found to do better; in other cases the girls do better. It is likely that the kind of material learned is an important factor, and that such differences as are found are due more to differences in interest or motivation than to any real difference in ability to memorize.

Suggestions for Directing Verbatim Memorizing

The aim in this chapter has been to place before the teacher the findings of careful studies on memorizing so that when he attempts to direct this kind of learning, he may be able to select or devise the most effective methods possible under the conditions of the particular situation. There is no one procedure that can be considered best for all conditions. Good teaching requires suitable adaptations to the conditions at hand. The following suggestions are based on the facts and principles surveyed in this chapter. It is intended that they be considered as guides in formulating suitable procedures and not as rules or laws.

1. The best procedures for directing memorizing vary with the age and intelligence of the learner, his former experience, and the nature of the material to be learned.

2. Things to be recalled together should be presented together and in the order in which they are to be recalled.

3. Use the whole method for short and easy passages, and a combination of the whole and part methods for long and difficult passages. Give special attention to the more difficult parts.

4. Use precaution to insure accurate first impressions. Avoid errors so far as possible, and check them on their first appearance.

5. Let the pupils practice some form of recall during memorizing, for this is conducive to a favorable attitude and provides practice on the functions which the learning is supposed to develop. Such recital, however, should not come so early as to encourage guessing. Errors made by guessing may seriously interfere with correct learning.

6. Secure the advantage of rhythmizing when possible. For very young children this may be accomplished by the method of reading or reciting aloud in concert.

7. Make use of artificial memory aids or mnemonic devices sparingly and only in the case of very difficult associations.

8. Provide for a sufficient number of repetitions or rehearsals to insure an adequate amount of overlearning. Learning to the point of

immediate recall only is not sufficient for schoolwork. For permanent retention review often at first. The length of interval between reviews may be increased as time passes.

9. Distribute the repetitions liberally. Make memory drills short, and stop at the first signs of fatigue. In selecting the most appropriate length of learning periods and intervals consider the age and ability of the child, the difficulty of the task, and the stage of learning.

10. Secure and maintain a desire to learn. Help the child to appreciate the value for him of mastering the material.

11. Commend earnest effort and inform the learner of his progress.

12. Secure and maintain full attention by starting promptly, by varying methods, and by using novel devices to make the work pleasant and interesting.

13. See that the child understands what he is to learn before he starts. The learning of meaningless material is sheer drudgery and an absolute waste of time for the school child.

14. Do not require children to memorize anything that will not serve some useful purpose or provide some pleasure or satisfaction for them. We cannot justify rote memorizing on the grounds that it improves the "faculty of memory."

15. Have the children make use of what they learn. Spelling words should be used in sentences and compositions, the arithmetic facts in problems, and gems of poetry may be recited on programs, or quoted by the pupils in their own writings.

SUMMARY OF THE CHAPTER

Memorial and imaginational recall tends to follow the trends laid down by the organization of perceptual trains. Memorizing is the process of developing associative tendencies which insure the recall of particular items in a definite and fixed sequence. Like other forms of learning it brings about functional change. The changes include eliminations, inclusions, substitutions, integration, and fixation.

Repetition is necessary for effective memorization. For retention beyond the learning period overlearning is necessary. This means that repetitions must continue even after recital is possible. Efficient memorizing calls for the distribution of the repetitions.

The difficulty of memorizing seems to increase faster than the length of the material increases, up to a certain point. The difference between the increase in the amount of material and the increase in the difficulty of learning is less for prose and poetry than for nonsense syllables and it appears to decrease as we pass to longer lists or selections.

As a rule the items standing at the beginning and at the end of a series are learned sooner than those falling near the middle. Rhythm facilitates memorizing.

The learner's set is important. The desire and intent to learn are essential for best results. Attention is necessary for successful learning. Meaningful material is learned more easily and retained better than nonsense material.

Many laboratory studies indicate that the whole method is more efficient than the part method. Because of certain disadvantages inherent in the whole method for use with children some combination of these two methods will probably be more satisfactory in most schoolroom situations.

Recitation combined with reading produces better results than reading with no recitation. Affectively toned materials are generally remembered better than indifferent materials. The relative effectiveness of different modes of impression appears to vary for different individuals. Concerted reading aloud seems to work out well for young children, but silent reading of the material produces better results for older children.

The individuals of any group will vary considerably in the rate of learning. The ability to memorize increases with age up to maturity. After about twenty-two years of age there is probably a slow decline in learning ability. Ability to learn corresponds more closely to the mental age than to the chronological age. Sex differences in ability to memorize are slight, and such differences as are found are probably due to different attitudes or experiences in relation to various kinds of learning materials.

The study of the conditions affecting memorizing provides a number of suggestions for efficient procedures in directing this form of learning in the classroom.

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CHAPTER XIV

COMPREHENSION: THE DEVELOPMENT OF UNDERSTANDING

The nature of comprehension. To comprehend means to understand. We comprehend when we grasp the meaning of a discourse, a sentence, a paragraph, or words that carry topical meanings. Our understanding of a subject consists of what we think about in relation to that subject. It depends upon a constellation of integrated associative tendencies laid down by related antecedent functions or previous experiences. Our concepts are the understanding we have of certain generalized and abstracted aspects of many experiences. Our understanding of what we hear others say or what we read involves more than the meanings of the various words as perceived. These various meanings are important to understanding, but in the process of comprehending they fuse, and the fusion yields a larger total meaning for the sentence, paragraph, or lecture as a whole. Comprehension is an organizing, synthesizing process that integrates experiences into larger meaningful units.

The outcomes of comprehension. As we apprehend an object in perception, we comprehend a *topic*. The topic, in other words, is the outcome of the comprehending. Through comprehension the student acquires in the history class an understanding of such topics as *the causes of the American Revolution* or *the westward movement*. In studying algebra he learns the meaning of *quadratic equation* and *radicals*. In the English class he comprehends *the principles of good writing* or *the nature of the sonnet*. In biology he studies the subject of *protective coloring* or *evolution*. In geography the child learns of *the relation of climate to modes of living* or *the industrial products* of the various states. The topic is an organized, coherent unit of knowledge. It is a comprehended subject, and as such it may be any generalization, such as a rule, a definition, a law, or concept. It usually involves a constellation of ideas, all of which are connected and organized around a central core, or idea, which bears the name of the topic and which incorporates the meaning of the whole topic. These associated ideas constitute what we know of the particular subject, and are the ideas that come to mind as we think about the subject. They are not set in a fixed train, as are the verbal responses of memorized material, but rather in the form of an aggregation. This form of association is called *topical association,* whereas in rote memorizing we have the *chain* type of association. The topical constellation is sustained by a pattern of associative trends retained as residues of former functions. We shall refer to these associative trends as *topical tendencies.*

Topical tendencies may be aroused by the sight of some object that represents or is related to the topic; or they may be touched off by the mention of the name of the topic by some other person. The sight of a schoolhouse may make us think of American education (topic). Our thoughts turn to the thousands of children who go to school, to their teachers, books, studies, examinations, the guidance movement, the increased high-school enrollments, teacher-training colleges, and so on. In the shifts of the ordinary conversation we may see many examples of the way the mention of a word may set off a whole series of associative tendencies of the topical sort.

Comprehending as a form of learning is the process of building these topical tendencies. Like other associative tendencies they are analogous to habit and probably no different from the ordinary reproductive trends except that they are so organized among themselves that they operate in groups.

Comprehension in the classroom. No other psychological function is used more in the classroom for purposes of learning than is the one we are now considering. Without it no reading could be worth anything and no study could be successful. Without it no explanation or demonstration by the teacher could accomplish its purpose and every lecture would be a waste of time. Without comprehension no assignment would set the pupil for the performance of the learning exercise planned by the teacher. Whether we teach in the lower grades, in the high school, or in the university, we spend a large part of our time explaining, lecturing, and prescribing reading with the expectation that through comprehension our pupils will become better informed and acquire an understanding of the subject we teach.

How comprehension takes place. Topics are developed by the enrichment of experience, by the differentiation of details, and by the synthesis of these details into a structural unity. The process of comprehension proceeds from vague gross impressions to clear-cut distinctions, and from a poverty of association to an abundance. Take, for example, the topic of *automobile.* For a young child and for many drivers the automobile is just a mechanical contrivance to ride in. If you do certain things to it, you can expect it to operate in a satisfactory manner. But when some delicate part gets out of adjustment and the motor refuses to start under the usual procedure, the person of such limited knowledge is helpless and must call for a mechanic. To the expert automobile mechanic the car is a very complex assemblage of parts. He knows all the parts, the purpose of each, the way they work, and the relation of each part to all the others. His knowledge is far more detailed and coherent than his customer's. The growth of scientific knowledge is a process of making finer and finer differentiations and more detailed classifications. Special terms often have to be invented to designate the delicate distinctions to the specialist. To the uninitiated these minute differentiations sometimes appear to be useless academic hairsplitting, but for the scholar they mean a deeper penetration into the subject, and more exact understanding.

In acquiring knowledge we may build up entirely new topics, or enrich those we already possess. A class demonstration of the former process was made in the following manner. The instructor asked the class whether anyone knew what an *esthesiometric compass* is. No one knew, so he proceeded to secure the development of a new topic. In asking the question he had presented for auditory perception the name of the topic. He next wrote the word on the blackboard so that the class could see it. First came analysis. What meanings were to be obtained from an examination of the various parts of the term? *Compass* was a familiar word. Someone volunteered, "It's some kind of an instrument." But there are different kinds of compasses. Distinctions were necessary. Attention was directed to the word *esthesiometric,* and someone picked out *metric* and said, "That refers to measurement." Putting together the two suggestions they got, "An instrument for measuring." But further differentiation was necessary. It was an instrument for measuring what? Then the first part of the term was examined. It provided a clue. Someone said, "Esthetics, that refers to beauty." This did not satisfy. Someone else recalled that this came from a Greek word, and that it appeared in other words familiar to him. He thought of *anesthetic,* and *kinesthetic,* and ventured that, "It refers to feeling, or sensibility." Then this was combined with the idea of a measuring instrument to produce the topical meaning, "An instrument for measuring sensitivity." But another differentiating step had to be taken. To prompt this step the question was asked, "What kind of sensitivity does it measure?" Since no one in the class could tell, the instructor explained that this instrument is used in the psychological laboratory for measuring on the skin the distance between two contact points necessary for the perception of two points instead of one. The topic was further clarified by producing one of these instruments for the class to see. It was elaborated by a demonstration of its use on one of the members of the class, by statements about the differences in sensitivity for two-point tactual discrimination on different parts of the body, and by explanation of the uses of esthesiometry in studies of fatigue. The members of the class then understood what is meant by the term *esthesiometric compass.* A new topic was developed. The process included analysis, differentiation, and integration.

This integrating, synthesizing feature of the comprehending functions may be observed as we come upon friends engaged in a conversation or enter a room where a lecture is in progress. At first the remarks mean little to us. As we piece together the various remarks, gestures, and facial expressions, the theme of the conversation or the subject of the lecture gradually dawns upon us. If we enter a motion picture theater and find ourselves in the middle of a feature, we at first hear voices and see the characters doing things, but there is poverty of meaning in it all for us. The scenes and sounds lack coherency. It is only as we begin to see the connections between the various remarks made by the different characters and relate them to the actions we observe and only as we realize the relations between the various characters that we are able to tell what the picture is about and find satisfying meanings in the minor details.

In many cases we increase our knowledge by enriching or supplementing topics already acquired. The city man may know something about farm life, but a week's vacation on a farm during which he helps with the haying and the milking gives him a fuller understanding of the life which the farmer leads. The average student knows something about earthworms. He has perhaps dug them and used them for fish bait. But after a few hours with one in the zoological laboratory his topical structure is greatly enlarged; he has learned many new things about earthworms. We all know something about rocks, but the study of geology will reveal to us facts concerning rock formations of which most of us have never dreamed. The child knows what a river is, for he has lived not far from one; but in the geography class his concept is broadened.

Functional change in comprehension. Through learning, modifications are made in the comprehending functions. As we learn by experience and study we come to understand differently. The topical meanings are altered. Our manner of thinking about a subject is changed. The types of changes are the ones we have encountered in the forms of learning already discussed, that is, inclusion, elimination, substitution, integration, and fixation. In the enrichment of the topical constellations considered in the last paragraph above, we have modification by the inclusion of new features. When the child discovers that Santa Claus is not a real, live, little fat man who wears a red and white suit and comes down chimneys to bring toys to good little boys and girls, and thinks of him instead as a happy symbol of the Christmas spirit, his understanding is changed by way of substitution. Eliminations occur as false conceptions are corrected. Integration takes place in the incorporation of various aspects of experience into the topical structure as described above. Fixation is seen in the all too frequent resistance to innovations.

Language and Comprehension

Language is a means of expression. It is also a means of communication. But for communication to take place the recipient must comprehend what the speaker says or what the writer has written. Topics are passed along from speaker to listener, from writer to reader, by way of language. The knowledge, information, or understanding, which the speaker or writer wishes to impart to others, is put by him into words. The recipient must translate the words back into topics. Each person in communication must always create his own topics from the verbal materials supplied by the speaker or writer. Some people believe there is such a thing as mental telepathy. According to this belief, for which psychologists have not found sufficient scientific evidence, it is possible for thought to pass from mind to mind directly without the intervention of the senses. We certainly do not have any such means available for classroom instruction. The teacher does not convey his understanding directly to the pupils' minds. He talks, and the child hears the vocal sounds. From these sounds the pupil gets meanings according to his own previous experiences and training, and these meanings yield in turn the topical meaning or his understanding of the teacher's statements.

Because of this indirect means of conveying topics it is sometimes difficult for one to make himself understood. Teachers sometimes take too much for granted and assume that if what they say is clear to them, it will be readily understood by their students. They sometimes skip steps through which the child must be led to reach a clear grasp of the subject because they no longer remember the steps they had to take at one time. The possession of expert knowledge does not of itself make one a good teacher. This knowledge must be presented so that the student can correctly comprehend it. There was wisdom in the advice given by a college dean to a student who was unusually clever in mathematics. She always received an "A" for her work in this field. Her papers, however, were frequently marked for omissions of steps which she thought were too obvious to require mention. She planned to teach mathematics in high school, but her dean advised her against this, for, as he explained, she would have difficulty in realizing the need for the careful, thorough, step-by-step explanations her pupils would require.

Spoken language is a vehicle of communication but each person builds his own understanding of what he hears in terms of his own previous experience and conditioning. His constructions are, moreover, subject to his own mental set, interests, biases, and moods of the moment. Mutual understanding requires a common background of experiences.

Sources of misunderstanding. When the hearer's *experience background* differs from that of the speaker, the former may put an entirely different construction upon the words of the speaker than that which was intended. A newspaper report told of two bandits who entered the office of a firm in New York, covered the employees with pistols, and demanded the payroll. "Let 'em have it," said the proprietor to his employees, meaning that they should hand over to the holdup men the $550 payroll. But these words carried a different meaning for the bandits. They thought the proprietor was telling someone to shoot them, so they opened fire. Two bullets struck and killed the man. The bandits fled without the payroll.

A statement may be misunderstood because of an inappropriate meaning conveyed by some key word. This misunderstanding may be traceable to differences in *conditioning* with respect to the *word meaning*. A man who was seeking employment was told that a job was open at the Eagle Laundry, but he did not think he could qualify because he had never washed an eagle.

Words that sound alike but that have various meanings are frequently sources of faulty comprehension, particularly when the child is more familiar with an inappropriate meaning than with the one needed. This type of confusion is shown by the student who wrote on his geometry paper, "A hole is equal to some of its parts." Children often reveal their misconceptions in drawings made to illustrate the poems or other matter read to them. After reading the poem "Barbara Frietchie" to a group of young children, a teacher asked her class to draw some pictures to illustrate it. One little girl produced the sketch shown in figure 28, and explained that it was a picture of "Stonewall Jackson riding a head."

In figure 29 is shown a school child's pictorial representation of "The Old Oaken Bucket." The child's explanation was as follows: "The cot of my father, the dairy house nigh it, the deep tangled wildwood, every loved spot which my infancy knew—these are the spots; here are the buckets." "But," the teacher remarked, "you have three buckets." "Well, there are three," replied the child, "the old oaken bucket, the iron-bound bucket, and the moss-covered bucket." Here the child used the meaning of the word *spot,* which she had acquired through experience. She had not learned that it could also mean a place.

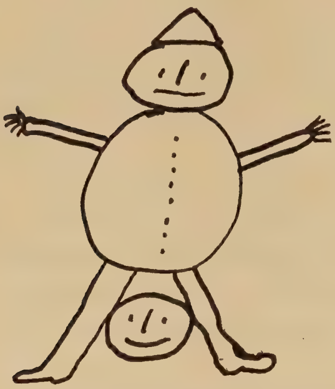
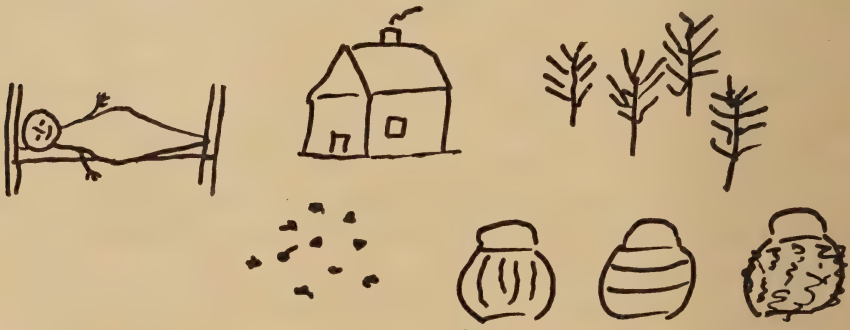


Fig. 28. A child's conception of "Stonewall Jackson riding ahead."

The influence of the home is reflected in the following case. A child was reading aloud to the teacher, who was giving him special remedial instruction. He read, "We get up in the morning, take a bath, and then smell. . . ." At this point he broke off, and said, "That's not right. We don't smell after we have taken a bath; we smell before." The rest of the sentence as printed was "the breakfast cooking downstairs." This also is an example of the way the whole determines the meaning of the part, and the way meanings may be misconstrued by lifting a part from its context.



From Professor Charles Frederick Whitney

Fig. 29. A child's drawings to illustrate "The Old Oaken Bucket."

Words frequently do not have the same meaning for a child as for the teacher or for the parent because the child's interests or values differ from theirs, and consequently the child does not clearly comprehend the question or remarks addressed to him. To "miss something," for example, may mean one thing in the child's way of thinking, and quite another thing to an adult. This was indicated in the reply of a little girl who had been absent from school for three days because of a minor illness. When her mother inquired after the child's first day back at school whether she had missed much during her absence, she answered, "Oh, no, not much. One boy threw up, and another bit the end off the thermometer. I guess that's all I missed."

Children acquire word meanings according to the usage in the community where they live. When they move to another locality where usages are different, they frequently encounter difficulties in comprehending what they hear. This was a major difficulty for children evacuees from England. Catherine Coyne tells of a little girl who wrote to her mother that in this country a *jumper* is called a "sweater," a *lorry* is a "truck," a *tram* is a "streetcar," and a *lift* is an "elevator." The following account of a conversation between a boy from England and an American boy outside a suburban garage is quoted from Miss Coyne's article (3).

> . . . . The Briton had been startled by a placard reading, "Flats fixed here." "That's a strange thing," he remarked to his friend. "Why should a garage be interested in flats?"
>
> "That's their business," the American explained patiently.
>
> "How can a garage be interested in flats?"
>
> "Because an automobile can't run if the tire is flat, so the garage fixes it."
>
> "Oh, I thought—Oh, I'm so sorry, I thought it meant a real flat, you know, what you call an apartment."
>
> The two boys continued to inspect the sign, and the Briton volunteered that in England a flat tire was called a puncture. Then he said, "But why should they fix it?"
>
> The American, exasperated by the cross-purposes of their conversation, asked tartly, "Well, what would you do with it?"
>
> "I'd repair it," the Briton said calmly.
>
> "Well, what does the sign say?" the American asked warily.
>
> "It says they would fix it, and that means they'd stick it, or keep it the way it is."

Another source of error in comprehension is *inadequate perception* of certain key words. A friend was standing by the elevator shaft waiting to go down. As the elevator came down from the floor above, the operator called out, "Going down?" The young man sprightly replied, "Yup." As the elevator passed by him he shouted "Down!" The operator stopped the car, brought it back to the floor where the fellow was standing, and remarked apologetically, "I thought you said, 'Up.' "

An acquaintance of the writer was teaching a class in English for adults. She had dictated some sentences for a study of figures of speech. One was particularly puzzling to a man about thirty-five years of age who had worked in the iron mines of Northern Michigan. The sentence as dictated was "Strike for your altars and your fires." This man had written "Strike for your alters and you're fired." He heard and interpreted according to his own experience as a miner. For him there was no figure of speech. Alter meant to change. If you go on a strike to get a change in wages or working conditions, you get fired.

Faulty perception of the words may be due to either of two causes. It may be due to an inadequate sensory impression, or to giving the wrong kind of meaning to the word sounds. Defective hearing, lack of attention, interfering noises, faulty enunciation by the speaker may be responsible for inadequate sensory impressions. Giving the inappropriate meaning to the verbal sounds is a matter of conditioning and perceptual trends derived from antecedent training and experience, as exemplified by the reactions of the miner mentioned above.

Comprehension and set. The construction a person puts on the words of another is often determined by his present mental set, desire, interest, bias, or mood. The superintendent of one of our state schools for the feeble-minded gave a lecture on feeble-mindedness to one of the writer's classes. He had described the various clinical types of mental deficiency including the mongoloid. Later on he spoke of the various forms of treatment and mentioned *euthanasia.* After the class was over, one of its members reported that when she heard that word she wrote in her notes "Youth in Asia." She quickly realized her error. But the first reaction had definitely been caused by the previous mention of the characteristic appearance of the eyes of the mongoloid. Later it was discovered that several other members of the class had reacted to this word in this manner.

A teacher said to a child, "You may sit here for the present." After sitting expectantly until he could no longer restrain himself, he asked, "Well, where is the present?" It could be that this child's reaction was due to his not having learned the time meaning of the word *present.* More than likely his concern for receiving a gift was responsible.

A cartoon by Gar Williams shows a woman saying to her husband, "Horace, I really think we ought to have a dog." The husband replies, "Now that's what I say. I'm for *that!*" But the insets depicting the thoughts of these two reveal that there is not the real accord which their words seem to imply. The lady sees a small fuzzy creature on a cushion, the husband a large handsome English setter.

Our own feelings bias our comprehensions. A depressed mood makes us take a casual remark by a friend as a reflection on our integrity. A guilty conscience makes us see an accusing slur in words never intended as such. An irritable mood makes us see implied criticism when the speaker had nothing of the sort in mind.

Gestures and signs. We comprehend the meaning of gestures and signs. A movement of the hand by the motorist signifies that a right or left turn is about to be made. The finger movements of the deaf-and-dumb alphabet make up a speechless language in which visual patterns take the place of auditory experience, but the process of comprehension is the same as for spoken language. Moreover, gestures frequently supplement the words of the speaker, and sometimes they suggest better than his words the message he wishes to convey. A demonstration is often the best way to impart information.

Written language. The signs we comprehend may be graphic or pictorial. A cartoon sometimes delivers a timely message. Our alphabet is a convenient device for constructing visual symbols to represent any object or thought within the range of human experience. Such symbols comprise our written language. In reading there must first be the *perception* of the word or printed symbol. This requires a clear sensory impression. Defective eyesight, inadequate illumination, or distractions may block the reading process at this point. Since reading involves a rapid succession of visual perceptions of word patterns, good eye-movement habits must be established.

Next, there must be *word recognition.* A person recognizes a word when upon seeing it he is able to speak the word, to pronounce it, or to point it out when he hears it spoken. One might be able to perceive a word as a word and not be able to recognize it. For example, we might observe some writing in the Russian language and realize that before us were words, but not be able to select from the group the word we hear someone speak.

Beyond the recognition of the word there must be *word meaning.* When the meaning of a word is grasped, the perception is symbolic and the word is a symbol. A person may be able to recognize a word and not know its symbolic meaning. This is the case when we locate a word in the dictionary in search of its meaning. A child might select a word from a printed list by sounding it out, or as a result of having memorized it, without knowing the meaning of that word. After learning how to pronounce the various syllables, a beginning student in Latin or German may be able to recognize and pronounce the various words and still have no conception of their significance.

In learning to read, the child usually acquires word meanings by associating an object or its oral symbol, the spoken word, with the printed symbol. When the association or conditioning is complete, the printed word carries for him the same meaning as does the spoken word. Later he may be able to derive the word meanings from printed definitions, explanation, or from context.

Finally, the reading process involves *sentence and paragraph comprehension*. Without this there is no true reading. The process of comprehending the meaning of a sentence or paragraph in reading is essentially the same as for comprehending speech. From the word meanings the reader formulates the topical meaning of the whole. Correct word meanings are essential for adequate comprehension in reading. We understand what we read in terms of our previous experience and according to our present attitudes. To be understood, the reading matter assigned to children must deal with things within the range of their experience. If it does not, the teacher must provide the experiences necessary for comprehension. Explanations of new terms, allusions, figures of speech, principles involved, or the use of pictures, diagrams, specimens, and the like may serve to give the child the necessary background for comprehending a passage that transcends his past experiences.

The experience background of children in our schools varies widely. Through the newspapers, movies, and home experiences pupils are often better informed concerning such topics as divorce, alimony, and bail money than they are on topics taught in the schools. The economic status of the home is an important factor in determining the kinds of experiences a child has outside the school. The income tax, for example, is likely to be better known by children in higher income levels. The adult conversations in the home, extent of travel, and the character of the community in which the child lives are all potent factors in determining the character of the child's experiential background. The diversity of these experiences from home and community life presents a real problem of adjusting instruction to the individual pupil's need.

Vocabulary. In any field of study the lack of a sufficient knowledge of the special vocabulary of that field impedes progress. Until we know the meanings of the special terms of a science, a business, or an art, we cannot read the literature in that field with adequate comprehension. Experimental studies have shown the value of systematic vocabulary training as an aid to the comprehension of subject matter. Students of ninth-grade algebra, for example, who were given special instruction designed to help them understand the mathematical terms and expressions with which they were unfamiliar made better records on achievement tests than did pupils of a control group who were not given such instruction (6). Likewise, special training on the meaning of certain geographical terms encountered in historical matter served to improve the comprehension of this material (23).

Various attempts have been made to secure better comprehension of the meaning of content by simplification of the vocabulary. In the case of some literary selections this has been successful. It should be remembered, however, that simplification of vocabulary will not be helpful unless it involves the substitution of words known to the reader for those that are not familiar. The mere substitution of shorter words, or of words selected from a list derived from counting those occurring most frequently in printed matter, will not necessarily make the material easier to grasp. In an attempt to discover the merits of simplifying vocabulary as an aid to comprehension, Nolte revised selections of reading matter by substituting words taken from the Thorndike Word List, and also by translating them into "Basic English." Care was taken to preserve the original meanings. This investigator concluded that such simplification did not make the passages significantly easier to understand (15).

While a knowledge of the meaning of the words is a primary essential for reading comprehension, there are other factors involved. One might know the meaning of every single word in a sentence and still not be able to grasp correctly the meaning of the sentence as a whole. Besides the subjective factors of set, there are the arrangement and complexity of sentence structure and the relations of the idea expressed to the experience of the reader. A sentence made up of easy words may express an idea which cannot be grasped by the reader because of its remoteness from his experience, or the sequence of phrases and a multiplicity of clauses may cause confusion.

For intellectual growth new words must be learned; but there is need for introducing them gradually. They should be definitely learned as they are encountered, and the load of new words should never be too heavy. They should be graded in terms of child experience and ability. The memorizing of definitions or one-word synonyms for new words is not sufficient. Real mastery requires associations with one's own experiences and a recognition of the relation of the new term to the context in which it is used. To make the new term a part of his permanent equipment the child should be given opportunity to use it appropriately both in his oral expression and in his written work.

But beyond vocabulary itself the thought expressed by sentences and paragraphs in reading material should also be suited to the reader's level of experience.

Verbalism. The term *verbalism* connotes the use of words without a knowledge of their meaning. All too frequently the student, unable to understand what he reads and faced with a test or recitation, proceeds to memorize statements from the textbook in order to have something to present to the teacher. He then reproduces words or passages he does not comprehend. This educational evil is fostered by bookish teaching, by asking questions framed in the language of the textbook, by accepting as answers words lifted from the book, by assigning material to be memorized without first seeing that the pupil understands it, and by failure to relate the material to the child's own experience.

A child aged twelve in the eighth grade of a junior high school of good repute was doing her homework in arithmetic. It was memory work, and after she had studied for a long time, she asked her father to take her book to see whether she could recite her assignment. The father was surprised to see that the assignment was the flat memorization of six tables of weights and measures. They were in the back of the book under the heading, "For Reference." They included measures never heard of by most adults, much less used by them. But aside from the utter waste of time and energy involved in memorizing them, they were absolutely foreign to the child's understanding. After passing grams, grains, gills, the number of square yards in a square rod, and the number of square rods in an acre, the child came to the table of cubic measure. She recited "1728 cubic inches equals one cubic foot, 27 cubic feet equals one cubic yard." Then her father interrupted and asked what that meant. She said she did not know. The father then explained the meaning of a *cubic inch, cubic foot,* and *cubic yard.* The child understood that readily. Then he asked her if she knew how to figure out how many cubic inches there are in a cubic foot in case she should not remember the number. She did not, and so was shown how to compute the cube of a number. When shown that all she needed to remember was to multiply 12 × 12 × 12 to get the number of cubic inches in a cubic foot, or to find the number of cubic feet in a cubic yard all she needed to do was to take 3 × 3 × 3, she grasped the principle at once. But it was a new idea to her. The teacher had said nothing of the meaning of the word *cubic,* nor had she mentioned the procedure for finding the cube of a number. Two things were wrong with the teacher's assignment. In the first place, there was no sense in having the child memorize this material. In the second place, no child should be asked to memorize material that is meaningless to him.

A friend of the writer had the following experience when she was a freshman in high school. The class had studied Silas Marner. Then came the test with the question, "What is the theme of Silas Marner?" The young lady wrote, "The theme of Silas Marner is the remedial influence of pure, natural human relations." She received an "A" and the commendations of the teacher. However, as she stated, she did not understand a single word of what she had written. In reading the preface to the book she had found that sentence and it sounded good, so she rehearsed it until it stuck in her memory.

A student of elementary psychology wrote, "Behaviorism is gondola secretions." The lecturer had said that behaviorism was the study of muscular contractions and glandular secretions. A young college instructor in American history had been discussing the court decisions of Chief Justice John Marshall. One of the cases reviewed was that of Marbury *vs.* Madison. After the whole topic had been covered, as he thought, pretty well, a freshman girl asked, "Is Versus Madison's middle name?" A young instructor in a high school was attempting to teach ancient history to a class of freshmen. The lesson was on ancient Egypt, and the textbook had told of the capitals of the various dynasties of some three thousand years B.C. The teacher asked for the name of the capital under one of the dynasties, and called on a lad whose home had been in a backward part of the state. The boy looked helpless, and the teacher asked, "What is a capital?" He did not know. Then the teacher asked him to name the capital of his own state. He could not do that. This boy could not even understand the first question, and the factual emphasis, to say the least, was misplaced.

That the salute to the flag and the routine concert recital of the pledge of allegiance is but an empty sham and devoid of meaning to a large portion of the children of whom it is required is indicated by what children write when they are asked to write out the pledge. A revealing study was made of such written pledges collected from children in grades V to VIII. In a group of thirty fifth graders who recited the pledge twice a week, sixteen wrote, "I pledge a (or the) legion." The word *indivisible,* in "one nation indivisible," was written in twenty-five different ways, but not once was it written correctly. The following are some of the ways it was written:

> "in the verble," "in diblise," "into besinble," "in vissilta," "into viszable," "intervisbul," "inda vevsable," "in vestable," "invisible," "in the visble," "and davisable," "in the Vizbee," "into visable," "inves abull."

The phrase "for which it stands" was frequently distorted, and "justice for all" was quoted as "just for all," "just as for all," "just is for all," and "busted for all." The following are exact reproductions of the whole pledge as written by three of these fifth graders.

> "I brith the flage of the United States of dismed and to the spries and it stands one monton in the besble with hevties and gustees and all."
>
> "I pledge the legion to our flag of the United States of Amieca, and to the republican for which we stand one nation and davisable with liberty of and justice for all."
>
> "I blidge a legion to my Amiacan flag and which it stand one nacion in the vizble and libdy of busted for all."

While the sixth, seventh, and eighth graders did somewhat better, so many errors appeared in their papers that it was evident that many of them did not know the meaning of the pledge. A large number, even of the eighth graders, wrote "I pledge a legion," and the word *indivisible* was frequently written, "invisible," "individual," or "intervisable." Yet this salute to the flag is required by state law, and children have been expelled from school for refusing to comply because of religious scruples of their parents.

Comprehension and the assignment. A teacher asks: "How can we get a child to follow directions as given? No matter how simply or briefly given, there is always someone who either through carelessness or misunderstanding fails to carry them out. How can we judge whether it is due to misunderstanding?" This teacher's problem is a difficulty encountered by all teachers. Failure to carry out an assignment may be due to lack of comprehension, or as the question implies, it may be due to other causes. Failure to comprehend the teacher's directions may be due to any one of the following factors:

1. Lack of attention. Here the words of the teacher would not be clearly perceived.
2. Sensory defects. If the assignment is given orally and the child's hearing is defective, he may not hear the words clearly enough to get the correct meanings. If the assignment is written on the blackboard, poor eyesight may prevent adequate perception.
3. The child may not know the meanings of some of the words used in giving the assignment.
4. He may know the meaning of each word and still through some bias or inappropriate mental set, fail to grasp correctly the meaning of the directions as a whole.

Probably the best way to find out whether the child has understood the assignment is to ask him to tell what he is to do. If he shows that he understands, it may be assumed that his failure to do as instructed is due to forgetting, inadequate motivation, faulty attitude, or lack of time or ability. Only as the source of this difficulty is located can adequate steps be taken to remedy it.

THE DEVELOPMENT OF CONCEPTS

The concept is a form of topic; and like all topics it is the product of comprehension. While the meaning of a sentence is ordinarily comprehended in a few seconds, the development of a concept may extend over a period of months or years. However, the process is similar, for in both cases a topical meaning emerges from a series of related experiences. The meaningful reference of the concept is not to a particular object but to a class of objects or to some common feature of many different experiences. Our concept of *rain,* for example, carries a broader meaning than that derived from perceiving a particular rainfall. It is what we know about rain in general. It is derived from seeing rain; from having it wet our clothing; from feeling it on our faces; from hearing its patter on the roof; and from observing its connection with dark clouds, flooded streets, dripping eaves, and the growth of plants. From these varied experiences with rain that which is common to them all, water falling from the sky in a vast multitude of drops, emerges as the universal property of rain. So in the development of any concept the qualities or properties common to a variety of experiences are detached or isolated from those other features which vary from one of the experiences to another, and these common qualities or universal features are organized into a new unit of understanding.

The development of concepts is related to the ability to perceive analytically, that is, to observe the various properties of an object or to apprehend the various features of a situation. Since the young child's perceptions are usually not analytical, he tends to take objects as a whole and without much regard to details. For this reason his first knowledge usually consists of gross concepts of broad and undifferentiated aspects of the world. He overlooks differences between objects of his large classes and reacts to these objects in approximately the same manner. He knows all automobiles as big things to ride in before he distinguishes different makes of automobiles. He knows dogs as four-legged, furry animals before he is able to identify different kinds of dogs. The gross concept of food as anything that satisfies hunger comes before the concepts of meat, potatoes, bread, milk, jelly, and strawberries. Knowledge advances with increased ability to notice details and differences, and concepts are refined and elaborated by distinguishing sub-groups on the basis of special properties belonging to each.

Language is an important factor in the development of concepts, for it furnishes a label for each newly differentiated aspect of experience. This label helps to mark off the newly distinguished feature from other aspects of experience, and makes possible the social correction of erroneous concepts. A child may have a few limited concepts of objects before he has names for them. These concepts consist of what knowledge the child has of these objects as a result of various contacts with them, principally what he does to them and what they do to him. But when language develops, most concepts bear a name. The meaning the child attaches to this name when he hears it as a word spoken by another person depends on the nature of his own concept.

A child normally forms a number of concepts before he enters school. These are usually gross concepts including only the broader classes of things such as houses, trees, chairs, and so forth, without clear refinements of sub-classes. They are ordinarily taken for granted by the teacher when the child begins to learn to read. If, however, a child does not have a concept for a particular printed word, it will be difficult for him to learn to recognize that word, and he will not be able to comprehend correctly sentences in which it is used. A child should know the meaning of the spoken word before any attempt is made to teach him the corresponding visual symbol.

Promoting the development of abstract ideas. Objects or situations which taken as a whole appear very different are frequently found under inspection or analytical observation to have some property or quality in common. When this property or quality emerges as an independent topic, we have an *abstract idea.* Take, for example, the property of redness. This color may be encountered in the perception of a blazing sunset, a lady's dress, a man's necktie, lips, fingernails, blood, flowers, and of many other widely differing situations. As redness is experienced in connection with many different things it tends to become dissociated from them all. Redness then becomes an abstract concept because it is detached in thought from the many different concomitants or elements which appear with it in the perceptions of the particular objects of which it is the color. The meaningful reference is generalized, because redness is known to be the property of many different things.

For promoting the development of abstract concepts in children two steps are indicated: first, the *location* of the property to be abstracted by an examination of concrete objects or situations possessing it; and second, the *isolation* of that property by varying its concomitants and by contrast.

Location. Location involves the apprehension of the property to be abstracted in the midst of other features of the particular cases used for illustrations. It usually calls for careful inspection or "piecemeal examination." Let us take as an example the concept of loyalty. To teach children this abstract concept we must help them to realize the nature of this quality or state and to develop the ability to think of it apart from particular persons or situations. Location of this quality is secured by presenting numerous and varied illustrations of loyal conduct. The examples should be examined thoroughly so that the children will see both the relevant and the irrelevant elements in the illustrations. They might be told the story of a dog that was loyal to his master. If we stopped there, however, the children might think that loyalty means a dog's devotion to his master. Since loyalty is to be found in very different situations and because many of the details of this illustration would be irrelevant to the meaning of loyalty, we must isolate loyalty from the irrelevant factors appearing with it in this and other particular cases.

Isolation by varying the concomitants. Isolation is the process of singling out or detaching the essential property or quality so that it will be comprehended as an independent topic. To accomplish this, several examples of devotion, faithfulness, and constancy should be given, and these should present different kinds of situations with different types of people. We should indicate not only what is meant by loyalty between persons, but also the meaning of loyalty to a cause, to one's school, and to one's country. The varying of the situations and connections in which loyalty is manifest will tend to separate the essential quality of loyalty from the irrelevant or incidental factors of the cases cited and to make it stand out by itself in the thinking of the pupils. To prevent any possible confusion with respect to the irrelevant factors, however, the employment of contrast is usually desirable.

Isolation by contrast. We complete the process of isolating the essential nature of loyalty by presenting examples of disloyalty. Here, factors appearing in the examples of loyalty will appear in the absence of loyalty. This should make clear to the pupils that these irrelevant concomitants are not included in what is meant by loyalty.

Abstract numbers. In arithmetic, a child acquires abstract number concepts. The steps through which they are developed are described above. The child must perceive the number aspect of groups of various kinds of objects. To learn the meaning of *five,* he must observe the number in a group of five things. We may show him five pencils. But we cannot stop there for he might think that five always has to do with pencils. So we isolate this number factor by varying the concomitants. We show him five apples, five boys, five chairs, five books, and so on. Each time he must notice how many things there are. Then to avoid any possible confusion with the irrelevant concomitants we show him by way of contrast groups of these same objects containing less or more than five. He must see that the number making up the groups is different from five. When the child can think of *five* without reference to particular things, he has acquired its meaning as an abstraction.

Particular experiences essential for abstraction. One does not develop abstract concepts apart from particular personal experiences. The man who has always been blind can never comprehend colors. The meaning of *honesty, hatred, sympathy, sickness,* and the like cannot be fully grasped by one who has not had firsthand experience with these things. Poverty of experience means insufficient detachment of the essential element from incidental concomitants and this means inadequate understanding. The following incident illustrates this point. A little boy's grandmother had died. The mother, wishing to shield the child from a sorrowful experience, decided not to tell him what had happened to his grandmother until a neighbor told her she had better explain the situation to him, for it appeared that he had a queer conception of death. The mother then decided to tell all, and as she took the boy in to see his grandmother's body, he began to laugh. The startled mother asked him why he laughed, and he replied, "Why, her face ain't cracked and her hair is on."

Children's concepts are often incompletely developed because of lack of sufficient range and variety of experiences. For them *obedience* may mean doing as the teacher or as mother says. For some children *patriotism* means saluting the flag or marching in a parade. *Justice* may mean a policeman's arresting a man. *Honesty* may mean never taking money that does not belong to you, but it may not cover abstaining from cheating in a social game. Adults make erroneous judgments and comprehend vaguely because of incomplete abstraction which leaves their thought confused with irrelevant concomitants of the essentials. Coal dust is judged to be rich soil because richness of soil is associated with blackness. A medical diagnosis proves to be incorrect because it is based on symptoms common to more than one disease. A child's failure in reading is erroneously attributed to low mental ability because he makes a poor score on an intelligence test, when actually the cause of his low score is his inability to read the test material.

In fostering the development of abstract ideas the teacher must provide for the necessary range and variety of experiences. Those experiences may be made more or less direct and firsthand by means of demonstrations, real objects, specimens, charts, diagrams, field trips, projects, or laboratory experiments; or they may be presented by means of reading and explanations. The number and variety of illustrations necessary to isolate the essential ingredient of the new idea will vary with the intelligence, maturity, and range of experience of the pupils. All illustrations and explanations to be effective must fall within the experience range of the learner.

There is danger that learning will be imperfect where only a single illustration is given. Young children and often older students are prone to take an illustration too literally. Then many of the irrelevant details of the particular case are incorporated into their concept. A child, when asked "What is faith?" replied that it was a monkey up a telephone pole. In attempting to explain faith to his class a Sunday-school teacher had told the story of an organ grinder's monkey that escaped from a dog by scampering up a telephone pole. He had pointed out that the monkey had faith that the dog could not harm him if he were up the pole.

Promoting the development of generalizations. A large part of our teaching is devoted to the development of generalizations. First there is the development of the meaning of nouns which stand for classes of objects, such as *river, tree, horse,* or *sentence.* The process by which these general meanings are developed is the same as for the development of abstractions, except that here instead of isolating a single feature common to many different situations we isolate and incorporate into the concept the several characteristics which are common to the various members of a class and which mark an object as belonging to that class. Other forms of generalizations are: rules of grammar or spelling, laws of science, definitions, axioms, and principles. A statement of any of these applies to many different particular situations and it presents a fact common to all the situations which the generalization covers.

In developing a general concept the first step is to *locate* the essential features and the second is to *isolate* these from incidental and irrelevant features of particular cases by varying the concomitants and by contrast. Suppose, for example, we wish to build up the concept of *river*. The child must first observe the essential features of a river. This calls for a detailed examination of some typical rivers. The child should note that each one examined is a natural stream of water, that it has a source, that it runs its course between banks toward some larger body of water situated at a lower level, and that it is part of a great drainage system. These features common to all rivers must then be dissociated from those characteristics of particular rivers that are not found in all rivers. We vary these irrelevant concomitants by the study of many different rivers. It will soon be discovered that some rivers flow north, some south, some east, some west, and many meander in various directions. Particular direction is then eliminated in favor of *any* direction. In like manner the essential features are to be divorced from particulars of location, sources, depth, length, width, and outlet. Isolation by contrast calls for a comparison with brooks, lakes, bays, and oceans, with a recognition of differences between these and rivers.

For the development of general ideas and an understanding of principles, rules, and laws, the use of a number of illustrations or examples is usually necessary. To serve their designed purpose these illustrations themselves must be readily understood. The use of a single illustration is frequently insufficient to secure the isolation of the essential features common to all cases covered by the rule, definition, or law. Such a failure to generalize from a single example is seen in the following case. A lecturer had described a form board test as an example of performance tests of intelligence. When asked later to explain performance tests, a student wrote, "A performance test is a test given with little blocks." Apparently other types of performance tests had not been incorporated into his concept.

Sometimes illustrations or analogies convey misconceptions because the related experience of the pupil is not what the teacher assumes it to be. A man in teaching a group of newsboys at a Y.M.C.A. was attempting to clarify the concept of God and was using the "father" analogy. A twelve-year-old boy in the back row jumped up and exclaimed, "If God is like my father, I don't want to have anything to do with Him." The teacher discovered later that this boy's father was a cruel drunkard. To be effective, illustrations must be related not only to the child's experience, but they must be related also to the appropriate kind of experience.

In developing generalizations it will not be necessary to start at the primitive level of concrete experience in every case. Explanations framed in general terms already familiar to the student may be effective. It may be expected also that the children of relatively high intelligence will require fewer concrete examples to reach a generalization than less gifted children (20).

COMPREHENSION BY MEANS OF DIRECT EXPERIENCES

Perceptual aids to comprehension. For centuries education in our schools has been predominantly verbal and bookish. The revival of interest in early Greek and Latin classical writings in the fifteenth century and the invention of printing established the educational tradition that to be educated was to be well read, and this conception of education has prevailed in spite of the protests of educational realists who have repeatedly pointed out the need for learning about things from firsthand experience with them. With the invention and use of such modern devices as the motion picture, stereopticon, and the radio a new insistence on the use of concrete materials has developed (11).

We have seen that comprehension rests on experiences which the individual has already had, that concepts grow from concrete experiences, and that the meaning of a word is clear only when one knows the thing it signifies. Perception of concrete things is basic to all understanding; yet ignoring this or in ignorance of it we have too often taught words without the experiential background necessary to give them real meaning. One way to promote comprehension is to enrich the child's experience by bringing him in contact with the real object he is studying. The student can get a far better concept of the amoeba by observing through a microscope a live one squirming around than he can from simply reading about it. He gains a better understanding of the nervous system of the earthworm by dissecting a specimen than he can get from a purely verbal description. The school excursion is a valuable aid to instruction when it gives the child the opportunity for observing at firsthand the situations or processes he is studying (9). A visit to a museum may provide the necessary experience to clarify a topic in history. Models and specimens in the classroom may make a point clear where words alone would fail.

Next to the object itself in point of directness of experience are pictures of the objects. Besides giving a more accurate impression of the thing being studied, pictures and real objects have greater interest and attention value for children than their verbal representatives. This makes for more vivid impressions and better retention than can be secured from verbal discussions. The motion picture has the added attraction of movement. It can be used to portray action and a continuous sequence of operations. Listening to a radio address by the President presents a much more vital and realistic situation than reading about it in the newspapers, or having the teacher tell about it. Other perceptual aids which may be employed in certain cases with profit to the pupil are: blackboard drawings, graphs, diagrams, maps, globes, bulletin boards, stereopticon slides, stereograms, demonstrations, and dramatizations.

The proper role of such materials of instruction is to supply experiences needed for comprehension. They serve as supplements to verbal instruction, not as substitutes for it. Such perceptual experiences as they provide must be directed toward the formation of concepts and generalizations in verbal terms. Meaningful experience naturally begins with the perception of the real object, but learning should move toward the level of comprehension where more varied and richer meanings can be assimilated from books and oral discussions.

Numerous experimental studies have shown the values for classroom instruction of motion pictures and other perceptual aids. They have also shown the unwisdom of indiscriminate use of them. In general, their use has been found helpful in those cases where the experiential background of the pupils is insufficient to enable them to comprehend verbal discourse. By means of pictures children can get a better idea, than from words alone, of the appearance of people and of scenes in foreign countries or of ancient times, where these differ considerably from the peoples and scenes familiar to them. The film is likely to be helpful where action or motion is an essential feature of the topic to be taught (10).

The effective use of classroom films or of the field trip calls for careful preparation of the pupils in what they are to notice and for the direction of their observations. Without such direction attention may be focused on some interesting detail which has no significant connection with the topic to the exclusion of more important matters. Also, some kind of follow-up work or discussion is usually needed in order to emphasize important points, to correct erroneous conceptions, and to place the observations in their proper relations to the subject being studied.

Laboratory experiments. The laboratory method of instruction is another means of providing firsthand experience. It has proven its value as an aid to the comprehension of principles of science. Under the microscope the student sees what his textbook tells about. In the laboratory he witnesses the chemical change taking place in the test tube, measures electrical current, obtains water by the explosion of hydrogen, and sees the effect of air pressure on the tin can from which air has been expelled. His observations provide the basis for clear and accurate understanding of scientific generalizations and the procedures that have developed our scientific knowledge. What he learns by his own experiments, he is not likely to forget.

On the other hand, merely going through the motions of an experiment, blindly following the directions of the manual, with no real appreciation of the problem and without discovering the true significance of the results by seeing them in relation to other facts, is waste of time. Moreover, the very simplification of the conditions in the common laboratory exercise gives it an artificial character and a detachment that may be fatal to the achievement of its purpose as an aid to comprehension. The laboratory exercise may become abstract in its efforts to be concrete. In using this method the good instructor will endeavor to secure a full appreciation of the aim of the experimental exercise, and will make every effort to see that the results are viewed in the light of the general body of facts they exemplify.

Participation in group activities. In recognition of the necessity for actual concrete experiences as a basis for learning, many modern schools have adopted a plan of instruction known as an "activity program." This plan conforms to the view that through engaging in various forms of activity, physical, mental, and emotional, the child develops an understanding and an appreciation of his environment and a knowledge of the society in which he lives. In the early grades the activities usually pertain to the child's immediate social environment, such as the means of obtaining food, clothing, and shelter for the family. Later they may deal with the lives of people more remote from their immediate environment, extending to the peoples of other lands and other times.

Such a program usually consists of a series of "units of activity" in each of which the children, often working in groups, contribute according to their talents and interests to some undertaking, such as building a toy city, making a circus, keeping a grocery store, building a train, making wax candles, constructing an Eskimo village, making an aquarium, or gathering a collection of cocoons. As an example of this realistic form of learning, let us look in on a third-grade group whose activity is centered around the topic of colonial life. Some of the children are dressed in the costumes of the Pilgrim colonists. A corner of the room is fitted up like the interior of a colonial home with a spinning wheel and iron kettle. A child in Indian costume is showing some other children how to plant corn, using a fish for fertilizer. Preparations are under way for a class-written play about an adventure of a Pilgrim child with an Indian. Around the room is a border showing Pilgrims going to church, turkeys, and pumpkins. On the wall is a picture of Pilgrims watching for the return of the *Mayflower*. The room fairly breathes the atmosphere of the old Plymouth of 1630. Several books on colonial life are to be found on a table. But these children not only read about Pilgrims, they actually are living the life of the early colonials in a most realistic manner. Through their active participation in this absorbing enterprise, the hardships of the cold winters, the difficulties of building homes on a desolate coast, and the dangers from Indian attacks become a reality to these children. These vivid experiences bring to them a much fuller understanding and appreciation of colonial life than could possibly be obtained from reading alone.

Similar advantages for comprehension are found in the "full-expression" plan, which has been used with excellent results in teaching the social studies in the junior high school. In this plan, as described by Powell (18), the work of the course centers around a few major topical units. As each of these topics is taken up, the pupils are asked to name some of the large fields of interests covered. These are written on the board and each pupil selects from the list one or two topics for a more complete study. The pupils are then organized into committees on the basis of their selections. Each committee gathers material on its special subject and makes a report to the class as a whole on the results of its investigation. The committees employ a variety of procedures in placing their findings before the class in novel and appealing forms. These procedures include: dramatizations, panel discussions, group discussions, debates, original drawings, cartoons, movies, still pictures, slides, manual projects, graphs, maps, music, original poems, stories, and book reports. Committees in a unit on Sectionalism *vs.* Nationalism, for example, were formed for the following topics: Cotton, Life in the Old South, The South Today, Negro, Lincoln, Biography, Tariff, Civil War, Reconstruction, and Music. The activities of these committees in gathering information and planning their presentations before the class have stimulated great interest in the topics. For developing an understanding and an appreciation of the meaning of the various topics of the social studies the plan has proven highly successful.

Study for Comprehension of Content

The term *study* is used to cover a wide variety of learning activities and various forms of learning. In this section we shall consider those forms of study which are aimed at comprehension of the larger units of subject matter. Such study involves the organization into topics of meanings obtained from reading matter. In reading for comprehension of content we seek to clarify our understanding and to extend our knowledge; in rote memorizing the aim is to be able to recite words in a fixed order. The reading assignments in such subjects as history, geography, social studies, and psychology should be comprehended, not memorized.

Study habits. A number of investigations have shown that the study practices of students in high schools and in colleges differ widely (7, 16). It appears that many do not know how to study efficiently and that a great amount of time and effort is wasted through ineffectual procedures and poor study habits. The methods used by a large proportion of students have resulted from a trial-and-error process of striving to meet the demands made upon them. Instruction in study procedures has for the most part been sporadic or incidental.

Experiments on training for effective study. The results of a number of studies indicate the value of special training in methods of study. Some of these studies have dealt with particular procedures in connection with a particular subject. For example, Newlun (14) found that training in the summarization of historical material in the fifth grade improved the learning of history. Barton (2) found that training in outlining and selecting the important points of content was an effective aid to comprehension.

In a comparison of two study procedures in high-school history made by Dynes (7), pupils who read, reread, outlined, underlined, took notes, and summarized were found to do somewhat better than pupils who simply read and reread the material.

An experiment is reported by Wagner and Strabel (25) in which groups composed mainly of high-school juniors were given extensive training in how to study. Some of the groups met five times a week for one semester, others met twice a week for one semester and three times a week throughout the second semester. The training was aimed at improvement of reading, vocabulary, memory, problem solving, note taking, preparation for examinations, and use of the library. In addition, each student was given encouragement and guidance in a personal conference. During the junior year the work of the trained pupils was significantly superior to that of the untrained control pupils with whom they were matched for intelligence, age, grade, sex, curriculum, and previous school record. While the trained groups lost some of their advantage after the training period, they continued to make higher marks than the controls. They also carried more work and failed fewer subjects than did the members of the groups that were not trained in study methods.

Jones (12) has described a course on the techniques of study given during the summer to students who had not made a good record in high school but who were about to enter college as freshmen. Twelve lectures were given on techniques of study and related general topics. Training was given on note taking, theme writing, rapid reading, and the assimilation of the content of reading matter. The course was regarded as helpful to the students. In another study it was found that junior-college students who used improved methods of study did somewhat better work than students who did not use them (24).

The effects of emphasizing methods and principles of effective study in a course in psychology were studied experimentally by Edmiston (8). The subjects were college freshmen students. Two groups of fifty each were equated in terms of intelligence and achievement. The two groups studied the same material, but the instruction of the experimental group stressed "how to learn," while for the control group no special emphasis was given to this matter. At the end of the semester the experimental group showed a significant average improvement in grades, both in psychology and in other courses, but no significant change appeared in the grades of the control group. The superiority of the experimental group, however, largely disappeared during the following semester after the special training had been discontinued. In a second study a selected group of low ability was given special instruction in how to study. Their grades in psychology showed marked improvement, but in other courses there was no significant improvement. Some who made relatively high grades in psychology showed a loss in other subjects. A study of the data from the first experiment also indicated that effects of the training carried over to other subjects only in the case of students who ranked relatively high in ability.

Study practices of good and poor students. The experiments described above have indicated the possibilities of improving scholastic achievement by training students in the art of studying. The next question to consider is that of the procedures which make for success in study. Several attempts have been made to discover what constitutes effective study by comparing the methods and working habits of good and poor students. It seems reasonable to suppose that methods used by the most successful students are the ones toward which training should be directed.

Douglass and Bauer (5) gathered, by means of a questionnaire, data from 395 high-school students in Minnesota. The questionnaire included fifty questions on study activity, note taking, and the ability to concentrate attention. The practices found to be associated with the better marks were: looking up new words in the dictionary, skimming before reading carefully, reading silently without moving the lips, preparing lessons day by day rather than cramming, studying just before class, and, in the case of the group of least intelligence, reviewing before an examination.

Weinland (26) obtained data concerning the study practices of twenty honor students in college by means of a questionnaire which consisted of seventy items. The factors ranking among the most important in relation to successful study as indicated by this investigation were: studying alone, taking courses in line with a selected vocation, resting when tired instead of working on, avoiding distractions while studying, working by assignment, stopping occasionally to think over what has been read, and the ability to read rapidly.

In a study of the differences between good and poor students reported by L. C. Pressey (19), 125 questions were submitted to some 250 students, and the results were studied in relation to their marks for the previous term. Elimination of students for whom data were incomplete left 200 whose records were used. The papers of the fifty students whose marks were lowest and the fifty whose marks were highest were selected for comparison. Of thirty items listed for which there was a difference of twenty per cent or more between the two groups the following are of special significance to the present discussion. A larger number of the best group had a regular place for study, had a daily study plan, lived where study hours were observed, made charts and diagrams to represent essential points, skimmed over a chapter, glanced at paragraph headings, or read the summary before studying the chapter, took notes on reading in outline form, and wrote summaries of material read. A larger number of the poor students had things on their desks which were likely to distract their attention, skipped over graphs and tables in their reading, and studied late the night before an examination.

Many factors influence school achievement. The problem of determining best study procedures is complicated by a multiplicity of other factors which contribute to the success or failure of study. Among these factors we have intelligence, health, time devoted to study, distractions, emotional disturbances, previous experiences or study, social habits, and attitudes. This means that some persons may succeed with a study method generally regarded as poor, while others will fail with methods usually found to bring good results.

Intelligence. In an attempt to identify some of the reasons for the outstanding success or failure of pupils at the two extremes of the achievement distribution, Abernethy (1) compared the twenty highest ranking pupils with the twenty lowest in a typical high-school freshman class having a total enrollment of 295 pupils. The rankings were based on school marks, and the comparisons were made with respect to differences in C.A., M.A., I.Q., sources of enrollment, sex, home environment, location of homes, school attendance, regularity of meals and sleep, clubs and hobbies, employment, and occupational choices. The findings with regard to age and intelligence were as follows:

Trait	*Best*	*Poorest*
Chronological Age		
Range	12-10 to 14-8	14-1 to 17-4
Mean	14-4	15-5
S.D.	6 mo.	9 mo.
Mental Age		
Range	14-11 to 18-7	10-3 to 15-4
Mean	16-9	13-3
S.D.	12 mo.	13 mo.
Intelligence Quotient		
Range	106-135	70-107
Mean	119	91
S.D.	9.03	9.6

It will be noted that the best pupils are on the average a year younger, but that in mental age they exceed the poorest by three and one-half years. The mean I.Q. of the best is twenty-eight points higher than that of the poorest. This is in keeping with the findings of many other studies which show that intelligence as measured by standardized tests correlates rather highly with school achievement. With regard to sex, it was found that the high ranking group consisted of five boys and fifteen girls, while in the low group there were thirteen boys and seven girls. There appeared no significant differences between the two groups with regard to the following items of home environment: living at home or elsewhere, number of parents not living, size of the family, birthplace of parents, language spoken in homes, occupational status of parents, number of homes having telephones, section in which homes were located. Half of the twenty poorest pupils came from outlying towns. This was out of proportion to the total number of pupils from these towns. The quality of the schools from which these pupils came and the more restricted experiences of these pupils may have been responsible in some measure for their relatively poor academic achievement. With respect to other characteristics the two groups showed only minor differences. The high group had a better attendance record. There was no difference with respect to regularity of meals. The high group appeared to be getting a little more sleep than the low group. About one third of the high group had no group activities, while two thirds of the poor group had none. They belonged to similar clubs. A larger number of the high group had some special accomplishment such as music or dancing. There was little difference with respect to number of hobbies followed in each group. The best pupils had broader travel experiences. There was little difference with respect to employment during the school year, but the poor group seemed to work more in the summer. The best pupils indicated higher ambitions for the future. It appears that differences in the homes and activities of the pupils had little bearing on the pupils' academic standing. The most outstanding difference between the best and poorest pupils disclosed by this study was the difference in intelligence as measured by the Terman Group Test of Mental Ability.

In a study by Reeder and Newman (21), of the relation of employment to the scholastic achievement of university students, the data for 246 students showed slightly lower academic records for the working students than for the nonworkers. The small difference was not statistically significant. But two thirds of the workers were below the average on the university intelligence tests, and the coefficient of correlation between hours of work and standing on the intelligence test was —.21. Workers also were found to come from homes of lower income and occupational levels than the nonworkers. These findings suggest that intelligence has more to do with the quality of a student's academic work than the amount of outside work he does, and that with sufficient ability a student may earn a part of his expenses without detriment to his school record.

Wilkins (27) reports that at Oberlin the students who participated most in extracurricular activities were on the whole the ones who made the best grades and scored highest in scholastic aptitude. There was no evidence that such activities were a cause of poor work.

Time spent in study. No matter how intelligent a student may be, or how effective his study habits are, it takes a certain amount of time to accomplish worth-while results through study. Insufficient time devoted to study may be related to poor budgeting of time, to lack of planning for study, to an overabundance of extracurricular activities, to employment outside of school, to illness, to an excessive amount of social activities, to plain indifference, or to any number of things which rob one of time which should be given to study.

Ryans (22) found a correlation of .37 between the time reported spent in study and college marks for forty junior-college sophomores. Other investigations have found these variables to correlate .32, .00, —.06, and —.28. It seems that the best students are not always the ones who spend the most time in study. How effectively one uses his time is, of course, a matter of considerable importance. Ryans reports that the time spent in study correlated with good work habits and persistence.

Broken homes. Although Abernethy's data disclosed no important home differences between his twenty best and twenty poorest pupils, the findings were not conclusive with respect to broken homes because such homes were not sufficiently represented in his two groups. The parents of all were living except the father of one pupil in the poor group and the mothers of three members of the best group. There is evidence from other sources that unsettled home conditions do have an unwholesome effect on a pupil's record. A comparison of the marks of 300 high-school pupils from broken homes with the marks of 300 pupils from normal homes paired for intelligence, sex, nationality, chronological age, and grade indicated that the school achievement of the pupils from the broken homes was inferior to that of the more fortunate pupils. The broken homes were those disrupted by the death of either parent, divorce or separation of parents, unemployment of the father, and employment of the mother outside the home (4).

The normal home situation is the best environment for the development of a well-rounded and wholesome personality. Where conditions like those mentioned above exist, the child is subject to various forms of emotional disturbance and conflict which distract his attention, undermine his efforts, and prevent the most effective application of his abilities.

There are, in fact, so many factors which contribute to poor progress in school that each instance of unsatisfactory work is an individual matter. Factors affecting school achievement are found in the student's social life, his physical condition, his emotional adjustment, his attitudes, aspirations, and the quality of instruction which he receives (17). These factors are interwoven and react on each other. Poor instruction may produce an undesirable attitude. A physical defect may produce an emotional disturbance. Too many social activities may rob the student of the required amount of sleep. A high level of intelligence may be rendered less effective by unfavorable conditions of study, and at the same time, it may enable the student to succeed in spite of handicaps where less gifted individuals would fail. In the interest of securing the best work possible we should strive to remove unfavorable conditions and secure as many favorable conditions as we can control. We may not be able to eliminate all handicaps, but if we can improve some of the conditions influencing a pupil's study, the results will justify the effort. Among the conditions which can be improved by an alert and informed teacher are the study habits and learning procedures. Every teacher should help his pupils learn how to study and prepare the assignments in his subject. The best procedures will differ for different subjects and for different age levels. The teacher should endeavor to discover the most effective study techniques for his particular class and instruct his pupils accordingly.

Suggestions for effective study. It is possible to state in a general way certain principles of effective study in the light of the results of many different investigations made on this subject. The teacher will realize in the light of the foregoing discussion that these are not absolute rules, that they will not guarantee excellence under all conditions, and that it will be necessary to make adaptations to the requirements of particular cases and special circumstances.

1. *Time.* An adequate amount of time must be provided for the study of each lesson if satisfactory progress is to be made. The planning and budgeting of one's time with a suitable apportionment for each essential task will help one to meet this primary requirement and will promote the efficient use of available time.

2. *Place.* Efficiency is promoted by regular work habits. For best results from study one should have a regular place for study, free from all unnecessary distractions. The desk or table should be clear of things that tend to divert attention from the work to be done.

3. *Set.* The time required for settling down to work is reduced and concentration is encouraged by the following practices: a prompt and determined start with the purpose of the assignment clearly in mind, a quick preliminary survey of the chapter by skimming or by glancing over the division headings, and reading the summary at the end of the chapter before undertaking the intensive reading of the chapter. Having in mind at the start what the chapter is about in a general way helps the reader to select the most essential points and makes it easier to organize them into topics.

4. *Practicing recall.* The practice of attempting at the end of paragraphs or sections the recall of the main points presented in them is an aid to the mastery of content. It is a good practice also to summarize in one's own words at the end of the chapter the main points of the whole chapter.

5. *Organization.* The ideas obtained from reading should be related and organized. In longer and more difficult material this may be promoted by outlining. A good outline will make the principal ideas stand out and show the relation of secondary or minor points to the major ones. Meaningful associations with previous experiences are helpful both to comprehension and to retention. Their number may be increased by thinking of original illustrations, by relating the new material to previous study, by using what has been learned in other courses to verify or evaluate the statements of the author, by making comparisons, and by thinking of possible practical applications of the principles presented in the text.

6. *Dictionary.* When new words are encountered, if their meaning is not clear from the context, the dictionary should be used.

7. *Application of effort.* Best results call for the application of wholehearted effort to the task at hand. Intensive work, however, requires an occasional pause for relaxation. The length of period during which full effort may be sustained will vary with the nature of the subject matter. In fairly heavy reading one hour is probably as long as most high-school or college students can apply themselves efficiently without a change. The value for efficiency of interspersed rest periods has been amply demonstrated, and this holds true for study as well as for other work. There are emergencies in life where a person must drive himself beyond the fatigue point, but this is unwise and seldom necessary in the sphere of study.

8. *Cramming.* One cannot accomplish in a few hours of intense and continuous effort what should have been spread over several weeks. Cramming is not an efficient method of study. Good students, more than poor ones, keep their work up by daily study. When this is done, there is no need for cramming. The habit of letting work pile up through neglect is found more often among poor students. They, more often than high ranking students, sit up late and study long hours before examinations (19). This practice leads to confusion and fatigue, both of which are unfavorable to a good performance in examinations.

9. *Review.* For retention, reviews are usually necessary. But reviews also have value for comprehension. Frequently, a second reading brings to light points missed in the first. In the light of the thought of the whole chapter as grasped in the first reading, new meanings may be found or more accurate interpretations may be given to various paragraphs.

10. *Notes.* The taking of notes is a good practice when it serves as a stimulus to the selection of the most important points, and when the

notes are used for making a quick review of these points. If notes do not serve in either of these two ways their value is questionable (13). Note taking on a lecture or on reading should be selective. It has been found that poor students more often than superior students take notes on lectures as fast as they can write (19).

11. *Study questions.* Study is more effective when the student has a definite objective. For the less mature learner this advantage may be secured if the teacher will supply questions to be answered from the material to be studied. Such questions will serve to guide the pupil's efforts toward the discovery of the points which the teacher wishes to stress. As intellectual maturity is approached, the student must learn to work independently. To do this he must acquire the art of following certain learning threads which will lead him directly to the heart of his subject. These threads consist of certain basic questions which may be asked concerning any topic of a given subject. In studying events of history, for example, the learning threads would include such items of information as: the nature of the event, where it took place, the date, persons involved, its causes, and its consequences. Only when a student knows the learning threads for the topics in his field of study and when he can ask himself the essential questions for which his study should find answers, is he ready to do effective, independent study.

12. *Written exercises.* The writing of a theme, term paper, or thesis on a topic is a good exercise for the promotion of comprehension of that topic. This is true for the following reasons: It calls for the gathering of information; it requires the systematic organization of one's ideas; and it brings to light hazy conceptions and stimulates the writer to clarify his own thought. This applies also to writing reports on field trips, laboratory experiments, collateral reading, or topics discussed in class.

Summary of the Chapter

Comprehension is the function through which we acquire an understanding of topics. Comprehending as a form of learning is a process of developing associative tendencies which determine what we think of when we think about a topic.

A large part of school learning takes place through comprehension. Topics are developed through the enrichment of experience, the differentiation of details, and the organization of these details into new structural units. Through learning our understanding is altered by way of inclusions, eliminations, substitutions, integration, and fixation.

We comprehend both oral and written language in terms of our own previous experience and training, and according to our attitude or set. When an individual lacks the proper experiential background, he is incapable of clearly comprehending what he hears or reads. Faulty perception of words precludes adequate comprehension. To understand the meanings of paragraphs and sentences one must know the various word meanings. Learning the special vocabulary of a new subject is essential for successful study in that field. Learning to recite words without knowing what they mean is called "verbalism." It is a common evil due mainly to poor teaching.

The development of concepts is an important form of comprehension. Our concept of an object includes all that we have learned about it from many different experiences with it. When some quality or feature common to many different situations becomes dissociated from all concomitants of particular situations and becomes an object of thought in its own right, we have an abstract idea. Abstractions emerge from particular experiences through location of the common quality or characteristic in the midst of its concomitants, and by the isolation of this feature through variation of concomitants and by contrast. Generalizations are developed in much the same way. A general idea refers to the characteristics common to a group or class of objects. Rules, laws, definitions, and principles are generalizations which apply to many different particular situations. The teaching of abstractions and generalizations usually calls for the use of several illustrations. A single illustration often results in incomplete isolation of the essential features of the concept from irrevelant features of particular cases.

Some classroom practices which facilitate or improve comprehension are: the employment of such perceptual aids as field trips, real objects, and pictures; laboratory exercises; and the participation in group activities centered around a topic of study.

Investigations have shown that students differ widely in their study practices, and a number of experiments have indicated the value of special training in effective study procedures. Studies of the differences between good and poor students indicate that academic achievement is influenced by a large number of factors. Important among these are intelligence, time spent on study, study habits, and emotional disturbances. Recommendations for efficient study for comprehension of content include: provision for sufficient time, a regular place for study, preliminary skimming or reading of summaries, practicing recall, organization of as many meaningful relations as possible, looking up new words, working intensively but not too long at a time, day-by-day study as opposed to last-minute cramming, reviews, taking notes on long and difficult material and later studying them, the use of study guides and questions, and the writing of themes, reports, and term papers.

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CHAPTER XV

SOLVING PROBLEMS BY THINKING

Elaborative thinking. The most exalted of all the psychological functions is the thinking out of the solutions of problems. Through it, under the directive and selective influence of the problem, the individual draws upon his knowledge and observations to produce for himself some new bit of knowledge, or to formulate some new conviction, opinion, or doubt. Through it he devises new ways of settling accounts with a problematic situation for which established methods are insufficient. The other functions, perception, memory, imagination, comprehension, and action, are basic to this activity, for the search for the solution of a problem may involve the use of any or all of them.

The term *thinking* as commonly used does not always refer to this elaborative function. We often speak of thinking *of* or *about* something. In such cases, the function may be memory, imagination, or comprehension. In memory we think of our first day at school, or the good time we had on a recent fishing trip. In imagination we think of coming events or of the absent members of our family. In comprehension we think about the international situation, or the current political campaign. After Bentley (2), the qualifying term "elaborative" is used here to restrict the meaning of "thinking" to the process of working out a solution to a problem. Elaborative thinking appears only when there is need for it, when the situation is baffling or unsatisfying, or when it presents a difficulty that cannot be met by other means.

The use of symbols. The use of symbolic meanings appears to be the distinguishing feature of this way of solving problems. It is the secret of the elaborative or creative aspect of this function. By means of the symbolic materials employed the individual passes from the facts at hand to the solution of the problem. We have mentioned symbolic meanings in previous chapters. We have seen that in perception an object may have a meaningful reference beyond itself, as when a red flag means danger, or when a blazing torch signifies scholarship. Here the objects are not perceived for themselves alone, but for what they represent. We have seen also that words are symbols when they stand for an object or some generalized aspect of many experiences. Our language is a great system of symbols.

Much of our thinking is done by means of words. Concept names are important symbolic materials. Words that carry topical meanings are especially effective resources for thinking. Their symbolic reference may cover a whole class of objects, or some abstracted feature of many different situations. The words we find so helpful in thinking may be spoken or they may be carried in inner speech by subvocal movements of the speech mechanisms.

Some writers have been so impressed by the large part inner speech plays in thinking that they have maintained that all thinking is simply a matter of contractions of the muscles of speech. It seems evident, however, that for many persons symbolic meanings may be carried by mental images, bodily postures, and movements of the body. The writer has on a number of occasions asked members of his class to think out the problem of securing a practical substitute for the stairway in their home. When the suggestions begin to come, a point we shall take up later, nearly always someone thinks of the possibility of using a rope ladder. This suggestion is usually discarded almost immediately. When the student is questioned, he almost invariably says that he had a visual image of his mother or grandmother dangling on a rope ladder between the floor and the ceiling. The literal meaning of the image was of minor importance. The real significance borne by this visual imagery was its symbolic meaning of inconvenience and that the rope ladder would not be adequate. So, a scrappy, even vague, image of a courtroom may carry symbolically the abstract meaning of justice, or a fleeting image of an airplane may symbolize aerial warfare.

Problem thinking also uses symbolic materials derived from perceiving. Here objects are perceived as signs, clues, or evidence because they point to facts beyond themselves. The detective sees in the footprints below the window not merely human footprints but evidence that the burglar left the house by jumping from the window. The signs of human agency, from which a conclusion of guilt or innocence may be drawn and which an alert detective is careful to note, may include sounds heard at the scene of a crime, such as cries of distress, the report of a gun, the breaking of glass, or the starting of a car. A bit of lint on the barrel of a rifle, or fingerprints on a glass, may prove to be the evidence which leads to conviction. In a notable murder case in Massachusetts a man was convicted by means of bloody footprints found on the floor of the victim's bathroom. In another case traces of fresh cement in a cellar led to the solution of a crime in which a man had murdered his wife and buried the body beneath the cellar floor of their cottage. In an experimental study of thinking, the writer presented to the subjects various pictures accompanied by a thought question. In these cases the clues were obtained from an inspection of the pictures. One of the pictures used was "The Lone Wolf." The question was: "Is it nighttime or daytime?" The clues to the answer were found in the darkened sky, stars in the sky, and lights in the windows (9). These were signs which indicated the proper answer.

The problem. In elaborative thinking one solves a problem. The problem is the motive of the thinker. It initiates the thinking and directs the process toward the solution. It is not the situation encountered that is the problem, but rather the individual's sense of difficulty or his desire to find out something. It may, as in the case of the task, arise from the occasion, from instruction given by another person, or from self-instruction. The first of these sources of the problem is illustrated in the case of the difficulty a man feels when, on driving through a strange part of country, he comes to a place in the road that is flooded with water too deep to allow his car to pass. Since there are no detour signs to point out the way for him, this situation arouses the problem of getting through to his destination at the appointed time. The second source of the problem is illustrated by the teacher's asking a thought question. This sets the stage for the problem. The child who thinks out the answer formulates the problem which he solves. In the third place, the problem arises from one's own interests, desires, or curiosity. This may be seen in the case of the scientist who formulates a problem to give definite point to a piece of research, or in the case of the man interested in fishing who puts to himself the question of the best kind of artificial bait to use in the lake at which he is to spend his vacation.

Problems do not always initiate elaborative thinking. They are often met in other ways. We frequently avoid hard thinking by recalling the products of former thinking, and by taking over uncritically the opinions and judgments of other persons. We sometimes imagine a possible answer to a thought question without troubling ourselves really to reason it out. In many cases a problem situation is attacked blindly by trial and error in overt action. It is usually only when such methods fail or will not provide an adequate solution or satisfactory answer that we really apply ourselves to the more arduous procedure of thinking out our problem, a procedure which calls for the assembling of data, putting details into new relations, and evaluating suggestions critically. We have elaborative thinking only when there is a real problem and when the solution to it is worked out by the use of signs, symbols, or clues.

Stages in the course of thinking. While the course of thinking out the solution of a problem varies somewhat for different cases, in general, examination reveals the following characteristic stages in the process: First, a difficulty is felt; second, the problem is clarified and defined; third, a search for clues is made; fourth, various suggestions appear and are evaluated or tried out; fifth, a suggested solution is accepted or the thinker gives up in defeat (cf. 2, 3, 4, 8).

1. *The difficulty felt is the problem.* It may appear as a perplexity, a bafflement, or a need for which established habits and ready knowledge offer no escape or means of adjustment. Expenses are found to exceed income; a child is ill; the car will not start; a tire goes flat before the spare is repaired; a skunk is digging holes in the lawn; water appears on the bathroom floor from an undisclosed leak in the plumbing; the opposing army puts into use a new and deadlier weapon; a crime is committed; or there is not enough fuel oil to meet consumer needs.

2. At first the nature of the difficulty may not be clearly grasped. Before a person can proceed successfully with the search for a solution, *the problem must be clarified and defined.* One must understand his problem in order to solve it. Failure to size up the situation carefully and to take account of all the significant facts is likely to lead to disastrous results or defeat. This is in some respects the most critical of all the steps. Scientific research grows out of clearly defined problems. The expert automobile mechanic locates the reason for the car's not starting before attempting to make repairs. The physician diagnoses the illness before he considers the type of treatment to be given. When the conditions of the problematic situation are not adequately analyzed and when the requirements are not definitely ascertained, false assumptions are frequently made. False assumptions with respect to the problem preclude a successful outcome of one's efforts to resolve his difficulty. The trained thinker takes care to avoid them. Emotional reactions and a biased point of view are also obstacles to clear thinking, for they operate against an adequate understanding of the problem.

3. *The search for clues or symbolic materials* is a quest for data that will throw light on the problem and point the way to a solution. It may include an inspection of objects for such signs as fingerprints, an examination and comparison of maps, and the gathering of relevant information from other persons or books. It may also involve a search within one's own associative resources by way of reflection on related past experiences. If the problem is clearly established and maintained, it serves as a guide in this search, preventing futile digressions and

random excursions. Successful search turns up evidence, and reveals significant relations between factors in the situation.

4. Out of the evidence and relations discovered by the search come various *suggestions for a solution to the problem.* From the data assembled through observation, recall, or imagination, inferences are made. Here the thinker passes beyond the facts at hand and ventures a guess, a supposition, or a hypothesis. The good thinker is both courageous and cautious in taking this step. For him it is not a random guess or a wild supposition, but an inference based on an analysis of all available facts. For him it is not the end of his thinking, for it must be evaluated and tested by the development of its implications in the light of knowledge and experience. He passes judgment upon the propriety of each suggestion before he accepts it as a conclusion. When through the exercise of critical judgment a proposal is found wanting, it is discarded and the search is resumed for another. When another appears, it too is evaluated. This proposing and discarding of suggestions continues until the individual either finds a suggestion which meets the requirements of the problem or until he gives up in defeat.

The able thinker is one who can produce a large number of suggestions, knows a good one when it appears, and can see the defects of a poor one. Extensive knowledge of the field in which the problem falls is conducive to fertility of suggestions and good judgment with respect to the propriety of them. The presence of rival hypotheses encourages postponement of the final conclusion until an adequate check has been made, and this lessens the danger of hasty and unwarranted conclusions.

When students are asked to think out the problem of finding a practical substitute for the stairway in their homes, the following suggestions frequently appear: ramp, fireman's pole, rope ladder, wooden ladder, and airplane. It will be seen that all of these are related to the problem and are derived from experiences with means of getting up to higher places. The directive influence of the problem is seen in the fact that while working on it no one thinks of such irrelevant matters as the current political campaign or the dance he attended the night before. In evaluating these suggestions the ramp is found to take up too much room; the fireman's pole might provide a quick way to come down, but it would not provide a satisfactory way of getting up; the rope ladder would be very difficult for grandmother to negotiate; and the wooden ladder would be unsightly, and inconvenient when carrying things. The idea of an airplane does not indicate a wholly irrational mind, for it is definitely associated with the various means by which we are carried up. However, the judgment of a person might seriously be questioned if he accepted the airplane as a final conclusion and attempted to put this conclusion into actual practice. The solution for this problem finally adopted by most students is some form of simplified elevator.

5. *The problem is solved* when a suggestion is definitely accepted. Such an acceptance may come when inspection or reasoning reveals that the proposal meets all the conditions required by the problem and when all rival suggestions are found to be wanting or less desirable. In some cases the suggestion or hypothesis is adopted as a conclusion only after it is tried out under practical or experimental conditions. Occasionally after a period of bafflement a complete solution appears with marked suddenness. This may be due to a new bit of evidence that throws new light on the whole situation and makes the solution clear at once, or to a new alignment of the details of knowledge already at hand, which reveals new relations and meanings. This sudden grasping of the means to a solution, as we have seen earlier, is called *insight.*

Solving problems in arithmetic. In working out the ordinary calculation exercises in arithmetic the stages described above are more or less foreshortened as a result of special training which the child receives. In the first place, giving the answers for such simple addition, subtraction, and multiplication combinations as $9 + 2$, $8 - 5$, or 3×6 after they are fully mastered does not call for elaborative thinking at all. The skills in the arithmetic facts are not mature until the answers have become habituated responses and the child does not have to count or use other devices to find them.

In the second place, suppose the exercise presented calls for the answer to the following: 8236×973. Here the child cannot merely resort to a ready-made association, for memorizing does not extend to such large numbers in multiplication. The child has a real problem when he feels he must find the answer. He probably will understand the nature of the problem readily if he has mastered the principles of multiplication normally taught before he would be presented with such an exercise. He does not have to search for symbolic cues, for the symbols are all furnished in the situation and their meanings have already been learned. Moreover, he has learned a fixed procedure for manipulating these given symbols for securing a series of other ones (multiplication of pairs of single digits and addition) which, if followed through, will lead directly to the solution. A problem is solved by elaboration, but the process has been reduced and simplified by previous training.

In the third place, there are the reasoning problems in which such operations as those mentioned above are to be employed but are not designated. Here the child must select for himself the principles and operations of arithmetical calculation needed to solve his problem. That children need special training in doing this is indicated by the fact that often a child may know how to add, subtract, divide, and multiply but still may not know how to use these operations in a reasoning problem. A child, for example, was given this problem: If you buy the stamps for six Christmas cards requiring three-cent stamps, and twelve cards requiring two-cent stamps, how much change should you receive from $1.00? She arrived at the answer 77 cents by the following method: $6 + 3 = 9$; $12 + 2 = 14$; $14 + 9 = 23$; $100 - 23 = 77$. This child knew how to multiply, but she failed to see where the problem called for multiplication. The mastery of the fundamental combinations furnishes the individual with excellent tools the use of which expedites problem solving, but he must learn how and when to use them. He must be able to select the appropriate operations in each case. There is no guarantee that training in the calculations alone will carry over to the solution of reasoning problems without training for such transfer.

The greater facility in the solving of arithmetical problems resulting from training is significant for our present discussion because it shows: first, that the ability to think out the solution of problems can be improved by training; and second, that the improvement in such ability results from acquiring knowledge or symbols to think with and also from learning the appropriate procedures for employing these materials effectively in working out solutions.

Thinking and learning. The process of thinking out the solution of problems is linked with the subject of learning in two ways: First, we learn by means of thinking; and second, we improve our ability to think by means of learning. Thinking considered apart from its connections with learning is an operation through which one achieves a certain type of goal, the solution of a problem, in a special sort of way (5). Thinking is a learning activity when it results in modifications of functional trends which are retained and affect the course of later activities. These later activities or functions include problem thinking, in which case we have the development of the ability to think as the result of learning. But the learning outcomes of thinking extend also to other functions. Through elaborative thinking we acquire knowledge and beliefs. These enrich comprehension, and their addition to our topical resources alters our manner of thinking about a subject. Through thinking we amplify our fund of memories, enlarge the scope of imagination, acquire control over emotional responses, and change our way of acting. In the chapter on perception we observed that thinking sometimes serves to develop perceptual meanings.

On the other hand, the ability to think is improved through functions other than thinking itself. Since problem thinking makes use of various other functions, such as perception, memory, and comprehension, the improvement of any of these may serve to enhance the ability to solve problems by thinking. We shall do well in considering the improvability of thinking to keep in mind that it is an activity, something the individual does. Thinking is not a "faculty" which is improved by mere exercise. As an activity it is improved by acquiring the tools to think with and by learning how to proceed in order to employ those tools in the most effective manner.

Problem solving by children. The young child's behavior in experimental problematic situations indicates that he learns by his own exploration and manipulation the possibilities of using various instruments or objects in such a way as to secure desired results (10). When children two or three years old attack new problems, such as those involving the stacking of two boxes or the joining of two sticks, the method employed is usually of the trial-and-error type. If then another problem is encountered which is similar to one already mastered there may be some transfer of experience which brings an immediate solution (1). Older children, having a greater fund of experience, solve more difficult problems and in solving them they manifest more insight. Their behavior in problematic situations indicates a greater ability to formulate and maintain a problem. Their attacks are more deliberate and systematic.

Thinking ability develops gradually. The ability to think out the solutions of problems develops gradually and increases with age (7). There is no specific point in the child's development where trial and error ceases to be the method for discovering solutions and where elaborative thinking takes over. Some degree of insight appears in young children when they see a significant relation between some object in the situation and their goal, as in the case where a stick is apprehended, not merely as a stick, but as a means for drawing a toy within reach. This has been observed in the behavior of apes, and in children about two years old. A little later memory and imagination may be brought to play upon the problem. First it may be an object not present in the perceptual field that is thought of as a means for reaching the goal. As understanding develops, concepts are used to advantage and we see the gradual emergence of more abstract forms of reasoning. Symbolic materials become available through the functions of memory, imagination, and comprehension. Suggestions for solutions may be derived more and more from past experiences and the need for the exploratory manipulation of objects grows less. The appropriateness of the suggestions, also, is weighed and estimated more by thinking of their implications instead of being discovered through precipitous attempts to act upon them.

Sporadic bits of elaborative thinking are sometimes observed in young children. They are limited in each case to the child's range of experience and interests. A child four years old, while watching the water run off from the kitchen sink, asked, "Is it like a little hill?" Though we cannot be sure just what the remark indicates, it appears that this child was bringing his knowledge to bear on the question of why the water was disappearing. A boy of six years asked his grandmother what *double* means. She replied that it means *two*. The boy came back with the remark, "Then Grace is double because she is two." Grace was his two-year-old sister. The outcome was faulty, but it was a clear case of inference, and the error was due to inadequate concepts rather than to the process itself. The effective use of general principles demands a clear understanding of the principles. An adult when trying to reason with insufficient knowledge makes errors similar to those found in the thinking of children. In novel situations when he is unable to find in what he has learned anything to help him out, he frequently reverts to trial and error in attempting to solve his problem.

Why adults surpass children in thinking. Adults, in general, can do better at thinking out the solution of problems than children. They are able to take a more objective attitude toward problems. Having greater emotional stability and control, they are likely to have less interference from emotional reactions. They can usually keep their attention on the problem over a longer period of time and hence are less likely to be thrown off their course by the intrusion of a new interest. The most important reasons for the greater thinking ability of adults, however, are their greater range of experience, better understanding, larger fund of well-developed concepts, and the fact that they have acquired certain general procedures for meeting and working out their difficulties (7).

A young child's needs are comparatively simple and for the most part they are satisfied by other persons. Hence, they do not so often produce real problems. The responsibilities of adults are often sources of problems. The child, lacking these, does not encounter problems so often. Limited knowledge often precludes the recognition of a problem. We are not aware of the problems in fields of activity wholly unfamiliar to us. The student frequently must be helped in finding a problem for research. But after he has worked on his problem for some time he discovers others, often in great numbers, without having to search for them. The child's limited experience often prevents him from becoming aware of a difficulty where an older person finds a real problem. A blowout of a tire furnishes a thrill of delight for the young son, whereas for the father who is driving and knows he does not have a usable spare tire the same incident presents a serious difficulty. Ignorance may be bliss by shielding us from problems, but when it prevents us from recognizing a difficulty that should be recognized and thought out, it precludes the first essential step toward a successful adjustment.

Not only is the child often blind to difficulties which present problems to more mature persons, but his limited knowledge makes him less able to comprehend the nature of the difficulties he does realize. He may sense that something is wrong, or know that he is confronted by a difficult situation, without being able to locate or define his problem. Since this inability prevents him from working out a solution for himself, he tries to get someone else to help him out of his trouble; and in the event this fails, he gives up.

In the next stage of the thinking-out process also, the child's comparatively limited range of experience and his meager fund of generalizations place restrictions on his ability to arrive at a successful solution. Excellence in thinking of this kind requires a fertility of suggestions for solution, and this depends upon the thinker's associative resources. The child is usually not able to bring to mind so many possibilities for solution as one with greater understanding and more extensive experience in the field of the problem.

Finally, the child generally lacks critical judgment. He is less capable of developing the implications of a suggestion and of determining its propriety by reasoning. This, too, is due to his limited range of information and understanding. It requires knowledge to be able to evaluate and judge correctly. The child is more likely than the adult to accept an erroneous conclusion because he is unable to see the fallacies or shortcomings of a proposal which would be clearly apparent to anyone possessed of greater knowledge. In situations unfamiliar to the adult, however, the quality of his thinking is likely to be similar to that of the child.

The problem method of teaching. The good teacher will provide opportunity for children to learn by thinking out problems. There are certain definite advantages in this method of teaching. First, it is conducive to an alert, active attitude, which is favorable to learning. A good problem is a good motive for learning. Second, it is conducive to the building up of confidence in one's ability to work things out for himself. This has definite value for the individual's mental health, for one of the first principles of mental hygiene is that difficulties should be regarded as problems to be solved rather than as emergencies to be evaded. Third, the memory value is exceptionally good for results obtained by solving a problem; and if these results are forgotten, they may be thought out again in most cases more easily than the first time. Finally, this method of learning provides valuable training in facing and working out solutions of problems. Through it with wise direction by the teacher the pupil may learn the art of sound thinking. To secure a transfer from a particular field of instruction to problems in other fields, however, it is essential that the student be made aware of the general aspects of the methods and procedures which bring good results (12).

Knowledge is essential to good thinking. By supplying topical information and fixed associations we provide the child with equipment for dealing with problematic situations. But the child needs to be taught how to use this equipment. We commonly place too much stress in our teaching on memory work and on the comprehension of lectures and readings to the neglect of training in thinking. To promote the development of the ability to think out the solutions of problems, instruction must provide: first, information and memory materials, and second, training in the procedures for using effectively the factual materials so that pupils will be able to solve their own problems and arrive at conclusions of their own.

Directing and Training Pupils in Problem Solving

1. Arousing the problem. First of all in securing and directing problem-solving activity the teacher must set the stage for the problem. One of the simplest ways in which this may be done is to ask a thought question. Such a question is not one that can be answered directly by repeating something that has been read, heard, or otherwise learned, but one that calls for the production by real thinking of a new bit of knowledge, a new opinion, or a new belief. Problems also may be aroused by the assignment of exercises or tasks that bring the child into new situations for which his established modes of response are inadequate. It could be the problem of finding an effective means for raising funds to buy a new flag for the schoolroom, how to secure suitable costumes for the class play, or the need for making the school paper more appealing to the pupils.

Whatever its source, the problem must be adapted to the pupil's level of experience and understanding. For young children it should be comparatively simple and related to a concrete situation and familiar materials. More difficult problems may be introduced to older children. For them imaginary situations and more abstract propositions may be employed.

The character of problems suited to the abilities of children of different age levels is shown by the age-group placement of the various problem questions in the standardized tests of intelligence. These problems have been tried out with large numbers of children and it has been found that the majority of children of the age level at which they are placed are able to solve them, and that they are too difficult for most children below the indicated age. Those appearing in the early age groups are comparatively simple, and from the lower to the higher age levels there is a progressive increase in difficulty (11).

Suitable problems for use in a particular school subject or in a specialized field of study are those calling for the use of principles and facts which have been taught and which the individual has learned in that subject. The problem is used extensively in arithmetic, but it can and should be used also in teaching any subject in the curriculum.

While the teacher may suggest a problem, it must become the child's own problem if it is to motivate thinking on his part. The teacher's assignment or question has aroused a real problem only when the child or student himself feels a need or desire to find the answer or solution. It is for this reason that the most effective thought questions are those that appeal to the learner's curiosity or are related to his own interests and welfare. A thought-provoking question is one that delivers a challenge; it is not one that strikes down a child and leaves him with a sense of failure or incapacity.

It takes more skill and originality on the part of the teacher to ask good thought questions, to arrange thought-provoking projects and activities, and on the higher levels, to direct research, than merely to ask questions of fact based on a textbook, or to pass out information by way of telling or lecturing. An investigation, in which the number and kinds of questions asked by fifty-six sixth-grade teachers of history were compared with the scores these teachers made on intelligence tests while in college, revealed that the teachers with higher intelligence asked a smaller total number of questions but more thought questions than did the teachers who rated lower in intelligence (6). When the teachers were divided into four groups from lowest to highest according to their intelligence scores it was found that the percentage of thought questions asked varied directly with the intelligence of the teachers. Assuming that thought questions stimulate thinking, we see that these results indicate that the more intelligent teachers secure a greater amount of thinking than the less intelligent ones.

2. **Comprehending the problem.** When the problem is aroused, the difficulty felt, and the need realized, the pupil is ready for the next step, which involves the clarification of the problem, its definition, and precise location. The significance of the question may be but vaguely grasped, or the nature of the difficulty may be incompletely comprehended. The pupil should be taught to analyze the problem to determine just what its demands are, and to study the situation to discover what is given. Only when the conditions of the problem are clearly understood is the pupil ready to seek out possibilities for solution. If the problem is too broad or too complex for him to grasp, he will not be able to deal with it systematically and effectively. A well-formulated problem exercises a selective control over search and recall, and this control is a vital factor in good thinking. A vaguely defined problem leads to mental fumbling and floundering. If a pupil is to learn how to think, he must be made to realize the need for determining at the start the nature of his problem. He should be warned of the danger of making false assumptions. He may need to be told to reread the statement of the problem and to examine its conditions more carefully. His attention may need to be called to some condition that he has overlooked. Sometimes a well-put question may help him to see more clearly the essential features of the problem. In some cases, as in a proposed research undertaking, it will be helpful to have the student write out a precise statement of the problem which he intends to explore.

3. **Searching for clues.** Superficial thinking and erroneous conclusions are the penalty for trying to solve problems with insufficient information. The discovery of relevant data frequently demands exploration and search. If the problem falls within a field in which the person has an abundance of experience or concerning which he is well informed, he may call upon his associative resources to great advantage. He may be able to solve the problem at once by recalling relevant facts

and by reorganizing them in such a manner as to meet the requirements of the situation. In many cases it is necessary for one to collect and organize new material bearing on the problem. Here the teacher may render valuable assistance without depriving the pupil of the opportunity to work out his own solution, and provide training that will extend beyond the particular exercise at hand.

In the first place the teacher can acquaint the pupil with the various sources of information and the proper way to consult them for securing needed material. It is important to know the best authorities in a given field. Usually the opinions of experts and specialists are more trustworthy than those of novices. The teacher should seek to cultivate a discriminating respect for recognized authority and caution in accepting the views of others. He may suggest procedures for reaching and consulting the most suitable and reliable sources of information. These sources may include such firsthand contacts as a trip to a store, a factory, a publishing house, the city fire department's headquarters; or a talk with the town treasurer, a selectman, a policeman, a doctor, or a minister. The teacher's task will also include instruction in the consultation of printed sources. He may suggest books to be read, or magazine articles. The pupil should be taught how to use the resources of the library, how to consult reference works, dictionaries, and the catalogue, so that he will be able to look up material for himself. He should be instructed in the use of books as sources of information on a particular subject. He should be taught the advantages of consulting the index and table of contents, and of skimming in order to locate quickly the material bearing on his problem. If the sources consulted contain tables, graphs, or statistical data which he is unable to interpret, he should be given the assistance necessary to enable him to get from them what he needs.

Besides knowing where and how to find material pertinent to his problem, the pupil should be taught to evaluate the sources. He should be able to distinguish between original and secondary sources, between statements of established fact and interpretations or opinions. He should be sensitive to the particular biases or viewpoints of the author consulted. He should learn to make allowances for the editorial policies of a paper, or magazine, and to consider the basis of a writer's claims. If it is a report on research, he should consider the reliability and completeness of the data upon which the conclusions are based. In the case of controversial subjects the statements of writers with opposed views should be compared. If a writer is advocating a cause, his statements should be weighed in the light of his motives. All possible angles of a problem should be investigated and the investigation should be thorough and systematic.

Finally, in order that the collected material may be most provocative of suggestions for solving the problem, the material must be organized or arranged according to a meaningful pattern. A mere accumulation of notes will most likely be of little value. The data, if extensive, needs to be sorted and classified topically. The making of an outline may help to throw significant relations into relief. Summarizing may also aid if it stimulates the selection of the most essential points from a larger mass of material. Guidance by the teacher in these matters will provide training in skills fundamental to successful problem thinking.

4. Securing suggestions for solution and their evaluation. The good teacher will avoid both the giving of too much help and the mere exhortation to think. The pupil should be allowed to do his own thinking, but the teacher can be of service by directing his attention to significant elements in the situation which he has failed to notice, or by asking an appropriate question to stimulate the recall of some principle or fact which has an important bearing on the problem.

If inferences do not appear readily, the pupil should be encouraged to search diligently for the right clue. His suggestions for solution or his hypotheses depend upon the relations he discovers among the facts and principles organized around the problem.

If the child seems blocked by a false assumption regarding the requirements of the problem, he should be asked to re-examine the problem.

If he persists in repeating a fruitless attack, he should be encouraged to vary his procedure and try out new leads. A good thinker is one who can readily change his approach.

If he is inclined to give up too easily, the teacher should urge him on and point out some of the possibilities which he has not explored. To become a good thinker the pupil must learn to be persistent.

If he appears tired, confused, or emotionally disturbed, he should be allowed to drop the matter for a while and return to it later. After a period of rest one is often able to pick up a new lead or see a clue which before had escaped his attention.

The teacher should point out to the pupil the need for an open-minded attitude and freedom from prejudice, for biases and preconceived notions are often fatal to sound thinking.

A willingness to venture a guess should be encouraged; not a random guess, but an assumption made deliberately with all the available facts in mind. Such an assumption is a hypothesis. Its merits will be determined by studying out its implications to see whether it meets the requirements of the situation. No harm is done if it proves to be a false lead. It can be abandoned if it proves to be inadequate and it might turn out to be a satisfactory solution. Great thinkers sometimes try out hundreds of leads before they find the right one.

The effective direction and training of pupils in problem-solving activity will foster a critical attitude toward the suggestions for the solution of a problem. To become a good thinker, the child must learn that when an idea for a solution comes to his mind, it should be regarded as a possibility to be tested out before it is accepted as final. He should be taught the importance of suspending judgment until all the available data on the subject are examined for evidence, and to consider the merits and disadvantages of the proposed solution in the light of all the information at hand. The merits of rival suggestions should be carefully compared. Some hypotheses may be tested by experimentation, and in the case of problems of practical adjustment, they may be tried out by attempts at application. The teacher may guide this process of elimination and selection by skillful questions or suggestions which bring to attention the defects of a faulty answer or inadequate proposal.

Since biases, prejudices, and old beliefs may blind one to the defects of a proposed solution or cause a person to reject a good one for no adequate reason, a good thinker will take precaution to avoid their deleterious influence. If the teacher will help the pupil to realize his biases and prejudices, he may thereby promote greater objectivity. When a person's thinking is motivated by a strong desire to invent a good excuse for his shortcomings in order to save face, or when he is set in his belief and seeks out reasons to justify that belief, he is likely to close his mind to all evidence incompatible with his purpose. This type of thinking is known as *rationalization*. It is a favorite device for escaping from a troubled conscience, the pain of frustration, and ego deflation. It frequently becomes a means of self-deception.

There are a number of things to consider in dealing with faulty proposals for a solution, or an erroneous answer to a thought question. In the first place, we should remember that courage in venturing a guess at the critical point where inferences appear is an asset to good thinking. It is the failure to develop the implications of the suggestion that is responsible for superficial thinking and erroneous conclusions. We must strive to secure critical evaluation without destroying the courage to formulate tentative proposals. If a sensitive child happens to give a ridiculous answer and is laughed at or made to feel ashamed because of it, he is likely to "close up" and refuse to attempt any further suggestions. Repeated authoritative rebuttals or denunciations by the teacher are likely to produce the same results. When a pupil suggests an absurd answer in good faith, his efforts should be met with a respectful request to tell why he thinks it is a good answer, or by questioning that will lead him to discover its defects. If he appears to be merely guessing at random, he should be reminded that he is supposed to find the answer by thinking over what he knows about the subject. In some cases where the child lacks sufficient information to see why his answer or proposal is inadequate, it may be necessary for the teacher to explain why his offering is not correct or sound.

Failure to detect the shortcomings of a proposal for solution may be due to faulty conception of the problem, lack of sufficient information, misinformation, biases and prejudices, unwillingness or lack of desire to exert further effort, or a false assumption of relationship. In helping the pupil to detect the weakness of his hypothesis or the error of his answer, the teacher should take notice of its source and make the attack from that point.

Summary of the Chapter

Elaborative thinking is an activity through which an individual arrives at the solution of a problem. The problem is a felt difficulty, and the solution is a new bit of knowledge, or a new belief. An important feature of this form of thinking is its employment of symbolic materials. Symbolic meanings provide clues, evidence, and flashes of insight. Just as all thinking is not problem solving, so all problems are not solved by thinking. We tend to avoid hard thinking by accepting solutions provided by imagination or memory. When experience or knowledge is lacking, we are prone to resort to overt trial and error. It is often not possible to tell from a person's response whether or not it is the result of elaborative thinking.

The characteristic phases in the process of thinking out the solution of a problem are: First, a difficulty is felt; second, the problem is clarified and defined; third, a search for clues is made; fourth, various suggestions for solution appear and are evaluated or tested; and fifth, a solution is accepted or the thinker gives up in defeat.

The ability to solve problems by thinking can be improved by training. This improvement results from acquiring the means (knowledge and symbols) to think with, and also from learning the best procedures for using these materials effectively. Learning and thinking are linked in two ways: First, we learn by thinking, and second, we improve our ability to think by learning.

Young children solve problematic situations mainly by overt trial-and-error exploration and manipulation. The ability to solve problems by thinking develops gradually with growth in experience and understanding. Children are inferior to adults in problem thinking principally because of their smaller range of experience. They are less sensitive to problems, have fewer concepts to work with, lack critical judgment, are less capable of sustained attention, and are less able to take an objective attitude toward their problems.

The problem method of teaching secures learning through the solving of problems. Its advantages are: First, it promotes an active attitude; second, it fosters confidence in ability to work things out for one's self; third, the memory value is especially good for things learned in this way; and fourth, it provides training in the procedures for thinking out solutions to problems.

In directing and training pupils in problem solving the teacher's task is: first, to set the stage for the problem by asking thought questions and by devising and assigning problem exercises; second, to assist the pupils in clarifying and defining their problem; third, to stimulate fertility of suggestions for solution and direct the pupil to sources of data bearing on the problem; and fourth, to foster a critical attitude toward the suggestions so that they will be properly evaluated and tested before being finally accepted as solutions.

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Chapter XVI

DEVELOPMENT OF EMOTIONAL ACTIVITY

The emotions and personality. An individual's personality consists in a large measure of his emotional predispositions and the character of those highly energized forms of activity which he manifests when he encounters frustration, insecurity, and emergency situations. Extensive differences between various individuals are to be found with respect to their propensities for fear, anger, jealousy, joy, and other forms of emotional upset. Persons differ also in the depth of their emotional stirs, the range and nature of the conditions that arouse emotions, and the manner in which they conduct themselves when in the grip of emotional excitement. An individual's happiness, his mental health, social adjustment, and conduct are directly related to his emotional life. Wholesome personalities do not lack strong emotions, but they differ from the weak, unstable, and poorly adjusted personalities with respect to the source of emotional disturbances, and the manifest behavior on occasions which give rise to them. Today, more than ever before, the possibility and the need for training the emotional activities are recognized.

Three aspects of emotion. Emotional activities are complex psychological functions. In approaching the study of emotions, one discovers that they present many facets. Some students of emotions have concerned themselves with one aspect of them and have neglected others. If we consider the total emotional event, at least three major aspects are to be taken into account. These are: first, skeletal or overt behavior; second, visceral behavior; and third, the emotional experience.

1. The skeletal behavior consists of the kind of activity we observe in another when he is angered, frightened, jealous, surprised, joyful, bitterly disappointed, disgusted, or grieved. We note for example the shrieks of fear, the threatening fist, scowls, smiles, laughter, sobs, the defensive attitude, shrinking, attack, and flight. Such behavior often, but not always, serves to reveal to others the character of the emotion which has seized the victim of inadequate adjustment to a difficult situation. The effectors for this behavior are the striated or skeletal muscles.

2. The visceral behavior, being internal, is not readily observed in another. Some of the observable effects of the visceral components are: the reddened or paled face, changes in breathing, dryness of the mouth, loss of appetite, urination, or defecation, which may occur in times of strong emotional excitement. Experimental studies have revealed that the internal changes in emotion include a stepping up of the pulse and breathing rates, an increase in blood pressure and blood sugar, increased activity of the adrenal glands and the sweat glands, and a cessation of the churning movements of the stomach. These changes are produced involuntarily, through the agency of the sympathetic division of the autonomic nervous system and the smooth muscles. While this widespread visceral activity is a characteristic part of the general emotional disturbance, many of these reactions occur in other circumstances, such as violent exercise, exposure to cold, painful experiences, and loss of blood. The activity of the sympathetic nervous system serves to maintain the essential uniformity of the internal environment, including the bodily temperature, and the physical and chemical properties of the blood. In the raw state of nature emotions are aroused by those situations which for survival require flight, defense, or attack. In such situations, there is survival value in the effects produced by the sympathetic nervous system. But for man, whose life must be lived on a plane of respectability far removed by culture and conventions from the animal instincts, the emotions can seldom serve their normal biological purposes. The internal changes when not used according to the designs of nature lead to internal turmoil which is often detrimental rather than helpful to successful adjustment.

3. The third aspect of emotion is the experiential accompaniment of these visceral changes and the overt behavior. This is not open to direct observation by anyone except the one who is passing through it, but for him it is the most significant thing about the emotion. It consists chiefly of a complex of organic and kinesthetic sensations toned by a high degree of unpleasantness or pleasantness together with the awareness of the emotional situation. Some psychologists have regarded this complex of sensory experience as the emotion, and the manifest behavior as its expression. On the other hand, certain behaviorists have regarded the overt and visceral behavior as the emotion and have ignored the facts of emotional experience because of their bias in favor of strictly objective methods of observation. It seems more appropriate to this writer to consider the total emotional event as the emotion. As such, emotion is a function which is touched off by the external situation. It runs its course according to the nature and predispositions

of the organism. It embraces both the emotional experience made up of sensations, the feelings, and perceptual meanings, and the emotional behavior consisting of the bodily reactions, overt and visceral.

The general course of the emotion. The first phase of the emotional event is perception of a situation. The specific character of the emotion depends upon the manner in which the situation is apprehended and upon the impulses which the perception arouses. Typically the situation is perceived as threatening, frightful, horrible, disgusting, or delightful; as one calling for defense, submission, attack, or escape. The situation is usually dynamic, and one in which the individual finds himself involved. The perception of it gives rise to a confused mind-body state which is to emotion what the task is to purposive action. The subject experiences a more or less violent surge of feelings. Widespread reactions take place throughout the visceral regions. Skeletal muscles are tensed. Next follow attempts to escape the predicament, to meet the impending crisis, or to ward off the threat of danger. In the more extreme cases these attempts are sometimes chaotic, as the individual finds himself unable to muster an adequate form of response. He may be overwhelmed by excitement or bafflement; his consciousness may be deluged by a rush of bewildering and confusing sensations. In his distraught state he strikes out blindly. Sometimes he dissipates his energy in ineffective and disorganized efforts to break the situation or escape from its clutches. Sometimes his acts are so unfortunate that his deeds cause lifelong sorrow or regret. Sometimes he is so overwhelmed that he is aptly described as "paralyzed by fear," "choked with rage," "prostrate with grief," "overcome with joy," or "dumb with astonishment." Finally, there is the stage of recovery. The upheaval slowly subsides, and gradually the individual regains his mental and organic equilibrium (cf. 15).

Emotionalized action. There are, however, cases in which the action trends are established so strongly as to withstand the shock of emotional excitement, or in which the emotional stir is not so violent as to prevent adaptive response. Here the individual's response to the situation is dominated by the action trends, and is energized by the emotional stir. It is emotionalized action. The individual displays unusual strength and endurance. The frightened boy runs faster, the angry fighter strikes harder, and the anxious mother displays greater resistance to fatigue.

This extraordinary strength and endurance displayed in emotionalized action is believed to be due to the organic changes produced by the sympathetic nervous system and the secretions of the adrenal glands.

Blood sugar is released in greater amounts, the pulse rate is increased, and the breathing rate is stepped up. These reactions provide an extra supply of oxygen and combustible materials for the muscles. Thus, reserves of energy are tapped, and at the same time, fatigue is momentarily overcome by the faster removal of fatigue toxins through the accelerated action of the sweat glands and by the increased rate of respiration.

The secret of adequate adjustment through an appropriate form of action, however, lies in the fact that the individual has a ready-made response for the emergency situation. A well-established habit, a reaction which has been trained, or a plan of attack already carefully worked out, provides a determination of action that withstands the emotional disturbance. The disruptive effects of the emotional stir are greatest in cases where the individual is not prepared, where a new form of response is required, where habits are inadequate, and where clear thinking is needed. In public places of entertainment the patrons are accustomed to leave by way of the front entrance through which they enter. In case of fire, their impulse is to hurry out that entrance. When several hundred frightened persons try to do this at the same time, the entrance becomes blocked and their customary action fails to provide an escape. It is then that panic seizes the crowd and tragedy reaps its toll of lives of the trapped victims. If the front exit does not become blocked, escape is achieved. In that case, an adequate adjustment to the situation is provided by the habitual form of response. If the mother sees her child pinned under the wreckage of a bombed building, her immediate impulse is to lift the timbers from the child's body. This is an obvious course of action requiring no deliberation. If she is able to free her child by this action, she will probably do so before she is overcome emotionally. But if her strength is insufficient for the rescue, or if she sees that her child is dead, her emotion is likely to become overwhelming. The inexperienced driver is more likely to "lose his head" and put his foot on the accelerator when he should put it on the brake for a quick stop than one who has practiced driving for many years. An adjuster for an automobile insurance company tells of an accident in which two cars were in collision. When the young women who were driving saw the cars coming together, they let go of the steering wheels, threw up their hands, screamed, and let the cars crash. A prompt application of brakes by both drivers could have prevented the accident.

Preparing for emergency situations. It is possible to prepare for many emergency situations in such a way as to insure prompt and adequate action and to prevent the disastrous consequences of panic. There are cases where an individual is so well prepared that when the dangerous situation is encountered, he reacts successfully before the emotional seizure arises. An acquaintance of the writer, for example, was driving a car in the wintertime. The streets were icy, so that it was impossible to make a quick stop by applying the brakes. As he approached an intersection, a car suddenly shot out from a side street directly into the path of an oncoming car. To avert a collision the latter car swerved to the other side of the street and was bearing down directly onto the friend's car. The use of the brakes could not prevent a collision. Our friend could not possibly dodge to the right of the oncoming car, for by momentum it was being carried too far toward the right side of the street. He jerked the steering wheel to the left, and escaped the crash by a narrow margin. This all happened in a flash. After the danger was passed, our friend experienced the emotional seizure. He found it difficult to breathe and waited a few minutes until he had gained his equilibrium. He had acted before he was upset by fright. The secret of his successful reaction in that situation was his fund of well-trained driving habits.

It is the situation for which one cannot muster an adequate response that overwhelms and produces panic. The emotional upset blocks clear thinking, precludes deliberation, and destroys the ability to formulate an appropriate course of action. This is why it is essential to have fire drills in our schools. To prevent panic, children should be trained in the course of action to be followed in the case of fire. This, also, is why we have air raid drills in time of war. The training maneuvers for soldiers not only serve to give the fighting men skills of warfare, but they also prepare for cooler heads in the heat of battle. To prevent the breakdown of suitable action in emergencies, we should train or practice the appropriate action as far as possible before the emergency arises. This, of course, depends upon our ability to anticipate the emergency. When it is our responsibility to provide such training for others, our emphasis and the learner's attention should be focused on the action to be carried through and not on the dangers involved. While it is generally desirable to face situations realistically, we should not pave the way for panic by picturing horrible possible consequences. The teacher in charge of the fire drill should not frighten children by harrowing accounts of fire disasters.

It is clear, of course, that we cannot practice the appropriate activity for all emergency situations which can be anticipated. Where actual practice is impossible or not feasible, the next best thing is to decide in moments of calm deliberation what one would do in case a certain emergency arose. Upon entering a theater, for example, one can look around and locate the nearest exit to be used in case of fire. An emergency situation will be less likely to overwhelm the person who has thought out a plan of action for it than one who is suddenly plunged into it with no preparation at all.

Emotional reactions of infants. The complex emotional activity we observe in a child or an adult is not an unlearned pattern of behavior laid down by heredity. It has a history of growth and development under the influence of consequences, social pressures, failures, and successes. Like other forms of activity, it is shaped by learning, and the process involves modification by way of inclusions, substitutions, integration, and stabilization.

Inasmuch as the emotional response is based on perception and the significance which the situation has for the individual, it appears unlikely that the young infant is capable of what we know as emotion in an older child or adult, since the perceptions of the infant are relatively undeveloped. Like the other activities, however, the development of the emotions starts with something provided by nature—an "unlearned nucleus." Certain situations such as a sudden loud noise, being pricked or pinched, being removed from the mother's breast while feeding, being deprived of food, being prevented from moving, and the like, call forth in the infant energized reactions commonly regarded as emotional. They include crying, starting, thrashing of arms, and kicking of legs. There is evidence also of the visceral type of behavior. But the overt reactions are diffuse and generalized. They are non-adaptive except for the fact that they are frequently useful in securing escape from discomfort by way of the ministrations of older members of the household.

There are no clear-cut differences in behavior patterns to suggest distinct forms of emotions in the first few days of life. This primitive, undifferentiated antecedent of emotions is probably best described as a state of excitement. It is marked by a general heightening of the infant's activities, and may be aroused by pinprick, hunger, uncomfortable clothing, or any form of overstimulation. From it, as the child develops, are differentiated the various forms of emotion which we recognize in the more mature individual (2, 3, 4). While the maturation of physical structures may be a factor in this process of emotional differentiation, it appears reasonably certain that learning plays the predominant role (18).

How different emotions are distinguished. The fact that we detect different kinds of emotion in children and adults leads us to the question of how we distinguish one emotion from another or tell what sort of emotion we have before us. In the first place, we find no differentiae in the visceral reactions. These components have been found to be identical in fear and anger, the emotions in which they have been most thoroughly studied. For the other emotions, such as sorrow and elation, little is known about them.

The character of the overt behavior of another person furnishes us with a clue regarding the nature of his emotion. The rising voice, violent words, and threatening gestures commonly indicate anger. Convulsive sobs and weeping suggest grief. Laughter, smiles, gleeful exclamations, and shouts are associated with joy. The pale face, shrinking, trembling, and fleeing are common signs of fear. Studies of the ability of persons to judge emotions from facial expressions as shown in photographs have generally revealed better than a chance percentage of successful responses (21). Yet the hazards involved in diagnosing another's emotion from its outward manifestations alone are apparent to anyone who has reflected on the matter. The overt behavior does not always reveal the true emotion. The various emotions often contain similar kinds of behavior. For example, crying appears in anger, grief, joy, and fear. There are individual differences with respect to behavior under the same conditions of emotional stimulation even in infants. As the individual grows up, he finds it socially expedient or even necessary to conceal and disguise his emotions. A person may smile to conceal his anger, or laugh to disguise his sorrow or fear. He may manifest a serious demeanor when courtesy demands it even though actually he is amused, or appear to be delighted when unwelcome guests arrive. At a dull party he must, to be polite to his hostess, give the appearance of having a good time.

In a study by Sherman (19) infants were subjected to various forms of stimulation to arouse emotional reactions and observers were asked to name the resulting emotions displayed by the infants. Stimulation consisted of dropping a short distance, hunger, needle prick, and restraint of movement. One group of observers were shown motion pictures of both the stimulating situation and the ensuing behavior. In the case of hunger, the observers were told what the stimulating condition was. For another group, the parts of the film showing the stimulating conditions were deleted so that the observers saw only the resulting behavior. Members of a third group were shown motion pictures presenting a stimulating situation followed, not by the behavior that situation actually aroused, but by the responses evoked by one of the other forms of stimulation. For a fourth group, the child was stimulated behind a screen which was immediately removed so that the observers saw the behavior without knowing the antecedent stimulating conditions.

The results indicated that the judgments of the observers were dependent in a large measure on their perception of the conditions which aroused the reactions. When the observers did not see the stimulation, they were unable to agree on the nature of the emotion. When they saw the true stimulating conditions, they agreed very well in naming the emotion, and did so in accordance with what one would expect as the result of such conditions. When dropping was observed, the emotion was named fear. When the baby was restrained, the response was called anger. But when the stimulus conditions and the responses were interchanged by means of the film, the judgments followed what would be expected from the situation. Thus, the reactions which actually followed restraint were called *fear* because what the observers saw as the apparent cause was the dropping of the infant instead of restraint of his movements.

We may conclude that while we distinguish the emotions of others partly by their behavior, we do so mainly on the basis of what we know about the situations which have aroused them. A certain amount of differentiation and patterning of emotional activity takes place as the child grows older, but even in adults, the behavior patterns for different kinds of emotion have a great many similar components.

The experiencing person is better able to distinguish his own various emotions because he has the advantage of knowing how he feels. In addition to knowing his own behavior he knows what impulses have been inhibited, what desires have been frustrated, and what meaning the situation has for him. This does not mean, however, that one can always describe accurately or name precisely each variety of his emotional experience. There are so many shades and degrees, and so many blends and combinations that the task of labeling and describing is most difficult.

Developmental Changes in Emotions

Beginning with generalized excitability, the emotional reactions early appear in the form of fear, love, and rage. Watson, who did pioneer work on infants, believed that a trained observer could detect even in the neonate differences in the reaction patterns for these three emotions, although he did admit that the three patterns contained many identical part reactions, and that at first they are "quite indefinite." These original reactions, he held, were called forth by a very small number of stimuli. He writes (20*a*), "They are certainly not the complicated kinds of emotional reactions we see later on in life, but at least I believe they form the nucleus out of which all future emotional reactions arise. So quickly do they become conditioned, as we shall show later, that it gives a wrong impression to call them hereditary modes of response."

As development goes forward, many varieties of fear, love, and anger appear. Probably there are as many variations in emotions as there are different ways of perceiving emotional situations and different impulses to react to them. Yet the familiar terms *fear, anger,* and *love* represent fundamental types and provide a convenient form of grouping for purposes of discussion. We may, therefore, consider the developmental changes in these as fairly typical of what takes place in the development of the emotional life. Modifications of the emotional trends are indicated by changes in conditions which arouse the emotions and by alterations in the mode of reacting when emotionally stirred.

Fear

Careful observations and experiments with infants indicate that fear is naturally aroused by very few forms of stimulation. It has been quite definitely established that without conditioning an infant does not fear the dark, fire, furry animals, or snakes, although fear of these things is commonly acquired rather early. The stimuli which elicit fear without previous experience are those which come suddenly. Quite generally, sudden, intense, and strange stimuli evoke fear reactions in infants, and these are presumed to do so apart from previous experience. In experimental studies by Watson and others, the fear reactions were aroused by a sudden loud noise, by jerking the sheet on which the infant was lying, and by dropping the infant a short distance. It is noteworthy that the element of *insecurity* found in these situations is the critical feature of all fear situations throughout life, though it appears later in different situations.

Changes in the sources of fear. During the preschool period, the number of fear stimuli is rapidly increased. At about the age of five or six months, a child sometimes shows signs of fear at the approach of strangers. This manifestation presumably is directly related to his growth in ability to perceive. A careful investigation of children's fears by Jersild and Holmes (8, 9) revealed that the most common fear objects of children under seven years of age were animals, noises and events previously associated with noises, falling or danger of falling, pain or persons and things which have been connected with painful experiences, strange persons, strange objects, and strange situations.

During these first six years, there is a decline in some fears and an increase in others. The percentage of children five and six years of age showing fear of noises, pain, falling, and strange persons and things, was smaller than for the younger children. But the older children exhibited more fears of bodily injury, darkness, being left alone, and imaginary creatures such as ghosts.

Whether or not a given object will elicit fear depends greatly upon the general surroundings and the condition of the child. For example, a child might not fear a dog if his mother is present, but be terrified if the dog comes upon him suddenly when he is alone. A loud noise does not frighten a child who is making it for fun. A child who enjoys being tossed up and caught again by his father may show fear if this is done to him by someone else.

As the child passes into later childhood, he continues to fear many of the things that frightened him in his early years. Sudden noises and threats of bodily injury, for example, are likely to continue to be provocative of fear responses. But there is, in general, a change in the character of the situations causing fear, and this change results in the elimination of many useless fears. The child discovers, for example, that many loud noises are harmless, and they no longer frighten him. Normally he is not afraid of a dog unless the dog is barking, growling, or threatening to attack him, or unless he knows the dog to be vicious. He may be afraid of all dogs because of parental warnings or because of some terrifying experience with a dog. Normally, he will not fear all strangers, but only those who are too aggressive toward him. Normally, he will not fear all forms of falling, but only those occurring unexpectedly and for which he is not prepared.

At this age, however, a new kind of fear situation appears, one that is most troublesome. It is the imagined situation which is not limited by the boundaries of space, time, or objective reality. One constructs by means of his own thoughts terrifying and dreadful situations, which produce worries and anxieties. These emotional reactions have about the same unwholesome effects on one's efficiency and conduct as do the fears touched off by perception. They may even be worse in their effect on the personality, for they easily become habits, and they are not restricted to the circumstances of the external environment. They may be elicited at any hour of the day or night, and they may continue their devastating work for days, weeks, or months at a time. The list of fears in the form of worries and anxieties suffered by children in the primary grades is a long one. The results from one study showed that the worries most frequently reported by sixth graders were concerned with matters of health, bodily suffering or injury, school marks, and grade promotion (22).

At the period of adolescence, physical violence and suffering continue to be important sources of fear, but to a lesser extent than in the preadolescent period. Boys and girls of the "teen" age are extremely sensitive about what others think of them, especially members of their own "crowd." Their fears center largely around social situations and relationships. Clothes, appearance, lack of poise, money enough to do as other young folks do, invitations to the right parties, the family's social standing, hurting other people's feelings, and the impression they make on others, are some of the more common causes of anxiety and worry for them (1, 16). They appear also to be the greatest sufferers from discrimination due to racial prejudices (14).

Adults worry mostly about their health, their financial security, and about possible harm to loved ones. The mother fears the danger which her soldier son must face, or the marriage which her daughter contemplates. The father worries about a possible accident when his son takes the family car. Adults are often subject to fears which beset children and adolescents, but in general the normal development releases them from most of the ill-grounded fears of childhood. Their fears are, as a rule, based on experience and relate to tragedies and misfortunes which they have seen overtake other persons. The emotionally maladjusted and immature adult, however, may have all sorts of irrational fears to beset and torment him.

New fears by conditioning. The fear reactions, like other forms of response, are subject to modification by conditioning. Some of the earliest experimental studies of infant emotions were concerned with this problem. The procedure was, in general, to combine a fear-provoking stimulus, call it A, with some other stimulus, B, for which the child showed no fear. It was found that after being subjected to such a double form of stimulation, the child displayed fear when B was presented without A. It seems that in this manner the child acquires a great many fears.

In one of Watson's early experiments the subject was an eleven-month-old boy named Albert. Before the experiment this child showed no fear of white rats. He did show fear when a loud noise was produced by striking a steel bar with a hammer. The rat was presented to Albert, and just as he touched it with his hand, the bar was struck. In response, he "jumped violently and fell forward." After five combined stimulations, the rat was presented alone. The child "puckered" his face, "whimpered, and withdrew body sharply to the left." After two more combined stimulations, the rat was again presented alone. As soon as he saw the rat, the child began to cry, "turned sharply to the left, fell over, raised himself on all fours and began to crawl away . . . rapidly." After a five-day interval during which he did not see the rat, Albert "Whimpered . . . withdrew right hand and turned head and trunk away" when the rat alone was presented. After he had played with some blocks, the rat was again presented. This time he "Leaned over to the left side as far away from the rat as possible, then fell over, getting up on all fours and scurrying away as rapidly as possible." Next in turn, a rabbit, a dog, and fur coat were presented to Albert, and in response to each, he displayed the same agitated negative behavior as that elicited by the rat. Here appeared the same kind of transfer of the conditioned response to similar stimuli which had been observed in experiments on conditioning of other forms of response (20*b*).

The picture is here drawn of at least one way in which new fears are acquired. Watson believed all the complex elaborations of the emotional life are built up by the operation of this principle. To many of us, this seems to be assuming a bit too much for conditioning. It seems likely that other forms of learning operate to produce many of the changes which occur in the development of the emotional activity. It does appear, however, that many objects become provokers of fear by being associated or identified with something which causes fear. A high-school teacher became frightened whenever a door or drawer stuck when she was trying to open it. Her trouble originated with a fright she had when a child. She was playing with her younger sister in the attic of their home. The younger child climbed into an old trunk, the lid of which fell down and became fastened. The older sister was terrified when she could not open the trunk, for she thought the child in it would smother to death before help could be summoned.

A little boy was brought to the school psychologist for a mental test. The child seemed afraid of her and all her efforts to secure his cooperation were futile. The examiner, realizing that there was no use in insisting, arranged for the boy to be brought back again in the afternoon. When he came in the afternoon, he behaved like a different child. He was most cheerful and coöperative. The examiner asked him why he would not do the things she asked of him in the morning. The child replied that he was afraid of her. When asked why he was afraid of her in the morning and not now, he pointed out that she had worn a white dress in the morning. He was not afraid during the second visit because the examiner had changed her dress during the lunch hour. A painful hospital experience had conditioned a fear of women dressed in white.

Another small child, after being taken on an elevator to the operating room at a hospital, screamed and struggled whenever his parents tried to take him into an elevator. The fear which some children have of the water may be due to their being lowered too swiftly into their bath when babies. Things associated with loud noises and things connected with bodily injuries that have been received are frequently feared by children. A child is not naturally afraid of the dark, but when a child is frightened in the dark by a loud noise, the dark easily becomes a conditioned fear stimulus. A child is not naturally afraid of dogs, but after he is bitten severely by one, he may be afraid of all dogs. Thus, the principle of conditioning operates to increase the range of objects and events which arouse fear.

Fears acquired by threats, suggestion, and imitation. It is likely that before the child learns to understand spoken language, most of his specific fears are acquired by conditioning. But when language is acquired, a new source of fear is opened. Suggestions of danger and dire consequences carried by casual remarks which a child may only partially understand, threats implied or directly made to the child, and stories of disaster and tragedy often serve to implant fear of a situation which had previously been faced with calm or even feelings of pleasure. The electric storm, for example, may become a frightful thing to a child as a result of hearing his elders tell of some person being killed by lightning. One child developed a great fear of death because an older boy had said as they gazed upon the worm-eaten carcass of a cat, "We'll be like that some day." Accounts of horrible suffering by persons in automobile accidents may make a sensitive child afraid to go in a car. Stories of ghosts and goblins may make being left alone in the dark a harrowing experience. Fear of negro men may result from the threat of having "a black man take you away, if you aren't a good boy." To threaten a child with such forms of punishment as locking him in a dark room, tying him up, or putting him in the furnace is to provide the sources of unwholesome fears. The hint by the teacher that "This is a very hard lesson," may be an incentive to a child with lots of self-confidence, but for a less fortunate one, it may arouse fear of failure. Warning not to go near any strange dog "for you might get bitten," may make a child afraid of dogs. Telling a child to be careful when he goes downstairs because "If you are not careful, you may fall and break your legs," is a pretty sure way to make a child afraid of going downstairs alone. Holding his hand and saying, "Now don't be afraid. Mother is right here with you. She won't let anything hurt you," can hardly be expected to develop courage in any child. It is significant in this connection that children in countries subjected to bombing by air have shown much greater fear in anticipating the raids than when subjected to the real thing. The source of their anticipatory fear is probably the talk of the dangers and hazards by their elders.

A child is, moreover, sensitive to the fears of others and tends to adopt them. If the first time he sees a snake his companions show fright, their fear may cause him to perceive the wriggling reptile as a frightful thing, and he will probably react to it as they do. Children tend to imitate the fears of their parents. Hagman (6) found a correlation of .667 between the number of fears of children and those of their mothers as reported by the mothers. Mothers tend to pass their own fears along to their children. Reports on the conduct of children during air raids indicate that the youngsters tend to reflect the emotional reactions of the older folks around them. If the adults remain calm and quiet, the children are less likely to become terrified than if their elders become panicky. As a result of suggestions, chance remarks, threats, and observing anxiety or panic in others the child learns to perceive situations as harmful or injurious and the list of his fears grows longer.

Comprehension and fears. The modification of fears on the arousal side is also brought about by the growth of understanding. The process of the development of understanding moves from the apprehension of gross situations to the refinements of reacting to various aspects or details of these situations, and in the development of concepts common elements of many different situations are isolated from the concomitants with which these elements appear in the various situations. In like manner, the fear reactions of the infant are evoked by gross situations. As development takes place, these situations are broken apart, analyzed, and the essential fear-provoking element is isolated. This means that when the fear element is absent, concomitants will not provoke fear. Where it is present even with new concomitants there will be fear.

The essential fear element of the diverse total situations which provoke fear is *insecurity*. To be insecure is to be in want of safety, exposed to danger or loss, or insufficiently safeguarded against hazards and risks. When darkness is a source of fear regardless of the total situation, the child has not distinguished the element of insecurity from its concomitants. The developmental stage corresponds to that of comprehension when the child calls all men "daddy," or all animals "dogs."

When he is afraid to be alone in the dark, but not afraid to be in the dark if his mother is with him, we have a first step in the direction of differentiation. At an early stage, a child may fear strangers. Later only strangers who are too aggressive are feared. At an early stage, a child may fear all dogs; later he fears only those that are barking, growling, or threatening him. Still later he may have no fear of some dogs which growl and bark, because he knows them and has learned that they will not harm him, while strange dogs growling and barking may cause fear. When children are questioned concerning their fears, they tend to specify the concrete objects or specific situations which produce their fears, not distinguishing between the essential fear element and its concomitants. For example, in a study reported by Cole, among the fear objects most frequently marked by sixth graders were such items as *gun, knives, fire,* and *jail* (5). The adult, however, whose emotional life has developed normally, does not find the gun itself a cause for being afraid. He is frightened when he perceives a situation in which his life is menaced by a gun, but the unloaded gun lying on a table does not disturb him at all. In some situations, the gun may be regarded as a safeguard against danger, and hence be the means of preventing fear. Likewise, fire is not a source of fear, except when it gets out of control, and the jail is feared only when one is liable to be confined in it.

The normal fears of adults are aroused by situations perceived as dangerous. It is not merely the presence of certain objects that alarm, but the threat of insecurity or harm found in the situations. With this change in the causes of fear that comes with the development of understanding many of the unnecessary and irrational fears of childhood drop out. There is no sense in being afraid of all loud noises. Many of them are connected with pleasures and business, and offer no threat of danger. Falling a short distance through space may be a lot of fun for a child if he knows he will land without injuries in the arms of a playful parent, or splash in water for a good swim.

On the other hand, as the threat of danger is singled out and is recognized in other situations, new fears appear. The adolescent finds in certain social situations and relationships a threat to his security, which for the young child is nonexistent. Likewise, the adult finds cause for fear in many situations that do not concern a child. So with growth of understanding comes the fear of such things as contagious diseases, inflation, financial troubles, failure, disloyalty, and loss of property or employment. The fears of the adult are more likely to be based on a knowledge of real dangers. It is not the object itself that constitutes the fear stimulus for the adult, but what he knows the situation can do to him.

Persistent fears. Unfortunately there are numerous exceptions to the normal course of development described above. Some fears, especially those conditioned by a severe shock or painful experience, are very persistent. They carry over from childhood into adult life and constitute the unreasonable and childlike fears which we frequently see in grown-up persons. The unfortunate individuals who are afflicted by such fears do not discriminate between the insecurity element and what constituted its harmless concomitants in the situation at the time of conditioning, and they continue to be frightened by perfectly harmless situations in which these concomitants occur. So we have adults who are afraid of the dark, of open bodies of water, of open places, closed places, cats, fire, knives, and all sorts of objects because these things were connected with some terrifying experience of childhood.

Often the victim of such abnormal fears or phobias does not know why he is afraid, but the fear habit is so intrenched that understanding is unable to eradicate it. The original conditioning event may be forgotten while the fear lives on to torment the victim in the most harmless of situations. A teacher whom the writer once knew was afflicted by a phobia for cats. She could not bear to remain in any room if a cat was present. In her childhood she had been bitten and scratched by a cat. No reasoning concerning the harmlessness of a particular pet cat could remove that fear. She was unable to discriminate between a harmless pet and a vicious, clawing attack. She still reacted to the harmless concomitants of the original harrowing experience.

The school as a source of fear. That the conduct of some teachers contributes to the increase of children's fears cannot be denied. In a study of the worries of school children, Pintner and Lev (17) found that most of the worries of children in grades V and VI were about matters connected with the family and the school. These writers characterized the school worries as "excessive" and stated that their results indicated that there was too much emphasis in school on failing a test, not passing, tardiness, and poor report cards.

An elementary school in the Middle West followed the practice of giving all the children of any room Friday afternoon off if no child in that room was tardy during the entire week. As a device to reduce tardiness, it worked, but how it worked! If a child happened to be tardy, regardless of the cause, he was attacked by the other children, slapped, bullied, and ostracized. The result was that when a child saw he was in danger of being late, rather than face the chastising by his fellow pupils, he turned back and went home. Too often in the past we have been concerned only with whether or not a management or teaching device works. The mental hygiene point of view is concerned with the way a practice works and its effect on the individual child's personality.

Fears may be engendered by harsh criticism, ridicule, sarcasm, blustering, and displays of temper on the part of the teacher; also by unwise punishments or threats of punishment, by threats of failure, and by humiliating experiences in the presence of other children. Some teachers frighten children by shouting at them; others do so by putting down grades while the child recites; and others by ill-chosen remarks which tend to undermine the child's sense of security. One of the most devastating fears is that of failure or the fear that one is inferior in ability. This is often caused by setting up standards of achievement incommensurate with the ability of the child, by unfavorable comparisons with other children, and by using the threat of not passing to stimulate the child to do his work.

Changes in fear behavior. Learning brings about changes in the overt manifestations of fear as well as in its sources. The earliest responses identified with fear are rigidity of the body, tenseness of muscles, withdrawal, whimpering, crying, and running away. These are fundamental elements in the behavior of a frightened person. At the age of two or three years, it is common for the child to scream and run to his mother. The mother's presence has come to mean security and comfort. To reach her is to escape from the threatening situation. Screaming, he discovers, attracts attention and brings help from others. For the young child, these responses work pretty well for dealing with the fear situations. But later, as his social life develops, their continued use brings unpleasant results. Other children laugh at his tears and call him a "baby" when he runs to his mother. To avoid the ridicule of his playmates, he finds it necessary to check his impulses and conduct himself in accordance with the standards of the other children.

As the child grows older, social pressures make it more and more necessary for him to conceal his fears. He accomplishes this in two ways: first by restraining his behavior; and second, by avoiding the situations of which he is afraid. At adolescence he is more than ever desirous that his fellows have a good opinion of him; and to rate well with the crowd, he must be courageous. He develops, accordingly, a greater subtlety for concealing his fears. He boasts of his courage and daring to conceal his real feelings, and offers ingenious excuses to prevent the intolerable revelation of the fact that he is actually afraid. Rather than admit he is afraid to fight he may declare that fighting is degrading and beneath his dignity. He may seek to conceal his fear of diving from a high board by telling the fellows his uncle, who is a doctor, says high diving is bad for the ears, and for that reason, he is foregoing the pleasure.

The adult finds a frank admission of fear socially acceptable in certain situations. As a rule he has greater control of his behavior and exercises more restraint in fear situations. He is aided in this by a greater repertoire of stabilizing habits than is possessed by the child or adolescent. His emotional reactions tend to follow an established pattern. Yet when the shock or strain is too great and when appropriate habits are not available, he may break through the acquired shell of restraint, and resort to the primitive, disorganized responses of crying, screaming, trembling, running away, or becoming rigid.

The unwholesome effects of fear. In certain emergencies fear tends to promote escape from dangers, and this is about the only good thing that can be said for it. The great bulk of the fears which torment children and adults are needless and detrimental. Fear is the enemy of mental and bodily health. It destroys courage and self-confidence, and undermines morale. It weakens and suppresses purposive action, distorts perspective, and inhibits clear thinking. It lessens the chances for success, and is often the cause of mediocrity and failure.

It is sometimes asserted that fear is valuable because it prevents action that would lead to harmful results and promotes the avoidance of danger. This reflects the inhibiting effect of fear. It is far more wholesome to establish positive impulses for beneficial action than to try to hold back action of the wrong kind. As a factor in adjustment, fear is negative. It is not a wholesome means of motivation. Its presence means failure, at least temporarily, to make an adequate adjustment. Habitual fear means habitual failure. Because of these unfavorable results of fear, the teacher's responsibility with respect to children's fears is threefold: First, he should avoid making the school situation a source of fears; second, he should promote courage and self-confidence, and help the child to acquire adequate responses to the situations which confront him; and third, he should help the child to overcome unwholesome and persistent fears.

Overcoming fears. The method most frequently used by parents in attempting to relieve their children of fears is that of verbal assurance (6). In using it an effort is made to convince the child that the situation is perfectly harmless and that there is no reason for being afraid. This procedure is not very effective if used alone. It may be of some help if the child has confidence in the one who is offering the explanation and if he sees that the latter is not afraid. Its use in connection with other procedures is recommended. A recognition of the unreasonableness of a fear, while a help in many cases, does not always enable one to overcome it. Also of little value are the practices of ridiculing or shaming the child, ignoring his fears, or forcing him to face or participate in the feared situation (10).

More effective than trying to talk a child out of his fear is an example of fearlessness. If the child sees that his parents, his teacher, or other children are not afraid, he will usually be able to face the situation more courageously. The fearless attitude of others is reassuring; it suggests that there is no real cause for alarm. Moreover, if he imitates their behavior, he may thereby acquire an adequate method of reacting to the situation.

A method which has been rather successful in overcoming fears in children is to present the feared object as a secondary part of a total situation that is pleasant. The procedure is to present the feared object first at a safe distance while the child is enjoying himself in some activity such as eating, and to bring it gradually nearer and nearer as the child becomes accustomed to facing it without emotional upset. M. C. Jones found that in this way children's fear reactions to rabbits or other small animals could be eliminated (11, 12, 13).

A study by Jersild and Holmes of methods used by parents in attempting to help their children eliminate fears indicated that the most successful procedures are: first, those which provide for the child opportunities for becoming acquainted with the fear situation by coming in contact with it frequently in his own normal activity; second, those which provide for contact with the fear stimulus first in a slight degree and then with gradually increasing intensity until it is encountered in its entirety; and third, those which help the child to develop skills which will enable him to cope successfully with the situation (10). A situation ceases to agitate and overwhelm an individual when he is able to make an adequate response to it. Repeated contacts with a situation without unpleasant consequences eliminates the element of strangeness, reveals the harmless character of the situation, and alters its meaning for the individual so that he no longer perceives it as threatening.

A case. George, a boy of nine years, was afflicted with an acute fear of the water. He was an only child; his father was a physician; his mother, a college graduate. His parents wanted to send him to a boys' camp, but believed he should learn to swim before going. The instructor of swimming to whom he was sent understood his fear problem and inquired into its origin. She learned that when he was three years old, while at the beach, two aunts of the boy took him into the water, where he was knocked down by a large wave and severely choked by the water. The unhappy incident had conditioned his fear.

The swimming lessons were given in a pool. The instructor spent the first half hour getting the boy to walk across the shallow end of the pool in the water. This required much patient coaxing and repeated assurances that nothing could harm him. As he timorously ventured to do it, he constantly clutched the edge of the pool. The boy did not want his instructor to go into the water with him. She surmised that he was afraid she would push or duck him, and was later convinced of this when the mother and one of the aunts came to watch the boy during one of his lessons. Impatient with the boy's hesitation, they both shouted, "Push him in!"

The lessons continued throughout the summer. He first became accustomed to the shallow water and learned to swim a few strokes. But after he learned to swim, he would not venture into the deeper water. The instructor then placed numbers at the side of the pool and urged him to work out to a farther number. This he tried, but all the time he clutched the gutter. He would not swim the length of the pool even with the aid of water wings or pole. He was afraid to jump into the water, but the instructor got him over that by having him first jump from the lowest rung of the ladder, then the second, and so on, until finally he had the courage to jump from the edge of the pool into the shallow water. But then he was still afraid to jump in where the water was deeper.

Finally on the day of the last lesson he did try jumping into the deeper water and enjoyed it. He kept on doing it past the hour for the lesson and asked the instructor if he couldn't do it some more. She told him he could if he would swim the length of the pool with the water wings. He did that, and then kept on jumping for a long time. The following summer he became a good swimmer and learned to do several kinds of diving.

In this case, we have a combined use of the various methods mentioned above. The instructor used verbal explanation and assurance; she set an example of fearlessness; she provided contact with the fear stimulus by gradually increasing degrees; she did not try to force him into the water; and she taught him a skill (swimming) for adequately coping with the deep water situation. As for the value of this treatment to the boy, if he had gone to camp with this fear, he probably would have been mercilessly teased and humiliated. What might have happened if he had fallen into the hands of a less sympathetic instructor who lacked the insight and skill of this teacher in dealing with his emotional difficulty? What if he had been pushed in as his mother and aunt advised?

Anger

In the case of anger, as in fear, changes both in the source and in the behavior occur through experience. Most children engage in displays of anger more often than they manifest fear. This may be due to the fact that outbursts of anger are found useful for attracting attention and getting what they want, while fears are more often concealed. Boys usually display anger more often than girls, perhaps because boys are more successful in using it to gain their ends.

Changes in the causes of anger. The manifestations of anger in young children are associated with bodily restraint, interference with activities in progress, and frustrations of desires. Throughout life the essential source of anger is some form of interference which retards the individual's advance toward his goal, or frustration which blocks the way to successful achievement of his purposes. In the young child the most frequent forms of interference are those which impede or prevent free bodily movement. Frustration appears in not being able to get some object of desire or in being prevented from continuing with some activity that has been started. To have his bottle removed unexpectedly before he has finished his feeding, to have a toy snatched away, to be held when he wishes to retrieve the elusive ball, are the kinds of situations which evoke in the youngster violent outbursts of temper.

As the child reaches the age of walking and becomes more active in manipulating things in his environment, the range of possible sources of interference and frustration rapidly increases. The mastery of language also opens new sources of irritation. At the age of six months, he will not be angered by taunting remarks or by having someone call him "names." At a later age, however, he will be quick to resent such insults. They interfere with his good thoughts of himself and conflict with his desire to command respect from others. In his play with other children, conflicts arise over playthings, and over the part to be taken in games. These developmental changes result from both maturation and learning.

As the child grows to maturity, the fundamental causes of anger are the same, though the situations differ. In general, the outbursts due to interference with physical activities decrease. During the period of adolescence the sources of resentment and retaliation are most often encountered in social situations. For the adult, the causes of anger are often the same as those for children and adolescents, but if he is emotionally mature he does not so often become angry at inanimate objects that impede his progress, and the social situations that arouse his resentment and indignation are less often personal. He is aroused by social injustice, by brutal or criminal conduct toward defenseless persons, by exploitation of the weak, and by ruthless acts of aggression by nations. Deeds that violate his sense of decency and humanity, institutions that operate against national welfare, and practices that undermine law and order draw the fire of his anger.

In anger, as in fear, the provoking situations normally change as understanding develops. It is the meaning which the situation has for the individual that determines its effect on him, and meanings change with intellectual growth. However, emotional outbursts are subject to habit, and we often find irrational childish reactions persisting through adolescence and into adult life because they have become the habitual way of responding to certain situations. Again, under great stress, fatigue, or sometimes through the accumulative effect of many minor irritating circumstances a person may become angry over something which under normal conditions would not arouse his ire. It also happens sometimes that a person harbors a resentment toward another who is merely associated with something which blocks the way to his goal. A jilted lover, for example, may feel resentment toward the girl's parents, who had nothing to do with her change of attitude toward him.

Changes in the overt behavior of anger. The infant's reactions to restraint are explosive and diffuse in character, poorly suited to eliminate the cause of his annoyance. Through early childhood his behavior becomes less random and more and more directed toward the thing which arouses his anger. He is likely to resort to various forms of attack, such as biting, slapping, striking, or scratching other children who interfere with his activity. If these forms of behavior are unsuccessful or are promptly squelched by elders or other children, they will soon be abandoned. If through these means the child triumphs in his purposes to get what he wants when he wants it, they may become his habitual method of dealing with interference. If they do not work, he may shift to other less aggressive forms of behavior such as screaming, throwing himself to the floor, holding his breath, pouting, or sulking. If by means of the temper tantrum or sulking he brings others to yield to his demands, these reactions are likely to become his stock methods for getting his own way.

The temper tantrum is unfortunately so often successful that some individuals never give it up but go on using it as a means of forcing other persons to yield to their demands throughout life. It is normally a young child's way of reacting to interference and frustration. When it persists into adult life it is considered an infantile reaction and an indication of emotional immaturity.

In the normal course of development the child encounters difficulties in his use of the crude forms of attack and learns that these and the temper tantrums are not socially acceptable. As he grows older he usually drops these childish forms of reaction and relies more upon verbal attacks. At the age of adolescence he may make use of epithets or sulking. The less aggressive person may withdraw from the situation and find solace in daydreams in which he pictures direful things happening to his antagonist.

The adult usually finds it expedient to restrain gross angry behavior. Resort to fist fighting between individuals is not considered respectable in most circles. Social custom dictates the legitimate manner in which insults and other annoying conduct may be redressed. The fighting of a duel was once the socially approved method of redeeming one's honor. Today the approved methods of attack are speech-making, law suits, and in war bombing raids and gunfire. In one's social and business relationships it is often necessary to conceal anger aroused by one's associates, and the emotionally mature adult is usually more skillful at doing this than a child. The individual tends to change his behavior in anger in the direction of social demands as he learns what society accepts and what it rejects.

Other Emotions

The many other forms of emotional activity such as joy, love, surprise, mirth, and grief also go through developmental changes under the combined operation of maturation and learning. Joy usually comes from some signal success or the sudden fulfillment of a great desire. But with development from childhood to adulthood the desires change and so does the character of the situations of success. The child is delighted with a new toy, the adult with a profitable business transaction or the securing of a professional honor.

The emotion designated "love" by Watson was aroused in the infant in his experiments by stimulating erogenous zones of the body. At least it appears that in the infant pleasure and happy states are the result of bodily stimulation. The young child's interests are primarily egocentric. His emotional attachment to his parents is probably conditioned by their association with the satisfactions of his physical wants. The gang stage just prior to adolescence shows the appearance of attachments to other persons outside the family circle. Such attachments are as a rule with members of the same sex. At this time boys like and associate with other boys but shun girls. In adolescence comes the turning to the opposite sex, the emergence of heterosexual interests and attachments. That biological factors of physiological growth, inwardly determined but stimulated from without, play a major role in this development is not to be doubted. Yet the conduct at these various stages is largely dependent upon learning in the form of becoming acquainted with the social norms and conventions and with the importance of conformity to them. In some parts of the world the approved and generally practiced forms of courtship and love-making are quite different from those which are customary among American youth.

Regarding surprise, its change with experience can be seen in its rapid decline when the situation arousing it is repeated. The knowledge of the adult will cause him to be surprised at things which would not arouse that emotion in children, and likewise will cause him not to be surprised where a child would be. Also with the growth of experience and understanding, and with the establishment of attitudes, habits, and ideals come changes in the situations which provoke mirth and grief, and changes in the manner in which these are expressed in outward behavior.

Other Affective Processes

Pleasantness and unpleasantness. The emotions are characterized by strong feelings. But feelings of pleasantness and unpleasantness are experienced in many situations which do not upset one to the extent of an emotion. Some stimuli such as sweet tastes, fragrant odors, harmonious sounds, and mild warmth are conducive to pleasantness without previous conditioning. Other stimuli are naturally unpleasant. A bitter taste, a painful burn, and foul odors are most likely to be unpleasant quite apart from any previous experience.

Many stimuli are pleasant because they satisfy a need or a desire. When one is very hungry, it is pleasant to eat good food. It is pleasant to escape from danger, to be relieved from pain, to secure the new toy, and to achieve success. It is not by learning that one finds pleasure in obtaining the object of one's desire. But many desires are acquired through learning. The stamp collector's desire for a certain rare stamp to complete a series of which he is very proud, for example, can hardly be considered a natural desire. A desire for a copy of a new novel may be the outgrowth of reading a previous work by the same author. The desire to spend a week at the seashore may have been aroused by a friend's description of the good times to be had there, or by the memories of the pleasant vacation spent there last summer. Unpleasant feelings are aroused by the frustration of desire or by obstacles which impede our progress in obtaining what we want. Insofar, then, as learning contributes to the development of our needs and desires, it serves to open up new sources of pleasant and unpleasant feelings. We also acquire through experience and conditioning various attitudes toward objects and persons which make them capable of arousing pleasant or unpleasant feelings. Likes, dislikes, interests, and sentiments are examples of such attitudes.

Moods. Moods are affective experiences which last longer and are less intense than emotions. Many of our moods are related in quality to certain forms of emotional upsets. For example, the irritable mood is related to the emotion of anger; the timorous mood, to fear; a cheerful or jovial mood, to joy; and sadness, to grief. This relationship of the mood to the corresponding emotion makes either a likely source of the other. First, the mood may be a lingering aftereffect of the emotion. Thus, an encounter which causes an outburst of anger may leave an individual in an irritable mood and his associates may find him testy. A fright may be followed by a timorous mood, and a joyful experience leaves the individual in a happy mood. In the second place, a mood makes a person more sensitive than usual to emotional stimuli and inclines him toward a particular form of emotional reaction. The person in an irritable mood is angered at the slightest provocation; the timorous mood disposes one toward fear; and a cheerful mood easily passes to a joyful emotion.

Can the moods be trained? An unqualified affirmation that they can be would hardly be justified, because the moods are largely the reflection of one's physical condition. Buoyant health is conducive to pleasant moods. Discouragement and depressed moods are frequently connected with faulty elimination or ill health. Much can be done to avoid these depressions by safeguarding the physical health, and the correction of an ailment helps to give the world a brighter hue.

Since moods are frequently the result of emotional upsets, the development of a more stabilized emotional life helps to reduce the incidence of moods. The adolescent with his proneness to emotions is particularly subject to moody spells, while the well-adjusted adult, being less often stirred up emotionally, is not so frequently the victim of moods.

While no claim is made that unpleasant moods can be wholly avoided by training, there are some things that one can do to avoid or break them up. The cultivation of a "calm frame of mind," looking for "the silver lining of the cloud," or at "the doughnut instead of the hole," and an honest effort to see the offender's point of view will help to prevent discouragement and lingering resentments. If one finds himself in a mood of depression, he should, if he wants to throw it off, trace back through the day's experience to discover its source. He may find it in a remark of a friend which hurt, or the annoying conduct of some pupil in the classroom. An intelligent analysis of the situation will probably reveal that ordinarily such an incident would not cause this unhappy state and that fatigue, a cold, indigestion, constipation, or some other physical condition is responsible for the fact that a comparatively trivial incident left a feeling of depression or an ugly mood in its wake. An honest effort to divorce the incident from one's feelings and steps to remove the physical indisposition will do much to restore a state of equanimity.

The Emotions and Mental Health

Mental health is dependent upon good emotional habits. The various forms of mental ill health are characterized largely by faulty emotional reactions. Neurasthenia is one of the milder forms of mental disorder. Its outstanding symptom is fatigue brought about by emotional difficulties which the victim has been unable to resolve. Psychasthenia is identified by bad mental habits of which worry and phobias are examples. Hysteria is marked by inappropriate and excessive emotional outbursts. In schizophrenia the emotional reactions are out of harmony with the patient's behavior and intellectual processes. Manic-depressive psychosis is primarily a disorder of emotional extremes. The foundation of mental ill health is often laid in faulty emotional habits acquired in childhood.

Today the school is recognizing and accepting its responsibility for safeguarding the mental health of the pupils. The concern of educators is with the welfare of the whole personality of the individual child. This means that not only his intellect but his social and emotional reactions must be educated. A wholesome personality is one that is well integrated. In the integrated personality the emotions, intellectual processes, and actions are coördinated so that they work together harmoniously for a happy adjustment to one's environment and for efficient intercourse with it.

In the interest of mental health a child must learn to face reality and to make the best possible adjustment to it. Some common sources of emotional maladjustment in the school situation are: sensory defects and physical handicaps; an appearance that singles the child out from the others, such as being red-headed, fat, unusually tall, or very short; inability to do the work assigned and failure; sarcastic remarks by the teacher; and unwise handling of disciplinary problems.

The teacher should be guided by the mental hygiene point of view. She should have constantly in mind the effect of her teaching on the emotional life of her pupils. She should seek to avoid those episodes which produce emotional conflict and to help the maladjusted child solve his emotional problem.

For the sake of mental health, special opportunities should be provided for handicapped children. This will usually call for individual attention. Merely putting such children together in a special class will not be sufficient. The fact of being placed in a special class may be, and often is, the source of further emotional difficulties. Some children become resentful, others are humiliated and made to feel inferior by being segregated in a group they know has failed to keep up with the average. The handicapped child should not be placed in a competitive situation where he is certain to fail because of his handicap.

Academic work should be suited to the abilities of the children at each age level. To prevent needless failure and its devastating consequences, the work must be kept down to the child's mastery level. Realization of the importance of this matter has given rise to a tendency to postpone some subjects of instruction to later years. For example, it has been found better to present long division in the fifth grade than in the fourth.

Disciplinary measures which crush a child's spontaneity and initiative are not to be tolerated. A good disciplinarian does not seek docility and timid conformity, but endeavors to train the child so that he finds satisfaction in harmonious coöperation with others rather than in creating disturbances. A child does not throw a temper tantrum because he cannot push over a brick wall or keep the milkman's horse. He may do so in the ten-cent store when his mother refuses to buy him a toy that he wants if he has learned from previous experience that he can make his mother yield by making a scene. In the former case, he has learned that he cannot do those things. In the latter, he has found that sometimes he can get his way if he makes a big enough fuss. Good discipline is consistent. It lets the child understand what he can and what he cannot do. Inconsistency and vacillation in disciplinary matters creates uncertainty, tensions, and conflicts, and encourages attempts to overcome the opposition of authority.

A well-planned activity program in which children work together in fairly small groups or committees, each contributing according to his talents and ability, each feeling that he belongs, each doing his work because of a real interest in the undertaking, and each receiving due recognition for his efforts, is a type of educational procedure which promotes mental health.

Emotional Conflicts and Escape Reactions

The term *emotional conflict* is used to cover a wide range of unpleasant experiences of varying degrees of intensity. It includes some of the distressing episodes considered earlier in this chapter under *fear* and *anger*. It also refers to such affective disturbances and tensions as anxiety, resentment, remorse, disappointment, regret, worry, and a sense of bewilderment or uncertainty. In this section we shall be concerned primarily with the sources of these unpleasant experiences and with the behavior through which an attempt is made to escape from them or effect an adjustment.

Sources of conflict. The character of a person's behavior is usually the result of several motives and tendencies operating at the same time under the limitations and requirements of environmental factors and conditions. In some cases, these diverse controls of behavior are so harmoniously integrated that the organism functions smoothly and efficiently, and the individual is happy and contented. But often our motives are in conflict with each other or with obstacles in the environment. We have impulses inconsistent with our attitudes and ideals. We have mutually exclusive desires; if one is satisfied, the other must be denied. We wish to do things forbidden by our consciences. We have ambitions that outrun our abilities, and drives that are blocked by unsurmountable obstacles. When the opposed desires and resistances are strong, the emotional reactions tend to be intense and distressing.

Escape and adjustment. One naturally seeks to escape from a painful situation, and one's behavior in emotional conflicts usually follows this rule. The individual strives to make an adjustment that will bring relief from his distress. He tries out various means, and in doing so may hit upon a way of dealing with the situation that restores comfort. This may be a good form of adjustment, or it may be only a palliative which in the course of time may prove detrimental. Again, it may be all right as an adjustment in that particular situation but altogether inadequate for meeting other difficulties. The danger lies in making one form of adjustment or escape a habitual mode of dealing with all troublesome situations.

Migration. In an effort to escape the painful stress occasioned by failure, bereavement, or tragic blunder some persons leave the scene of their unhappy experience. A man who lost heavily in a real estate deal moved at once to another town to get a new start amid new scenes and new faces. The old scenes continually reminded him of his unfortunate mistake, while amid new surroundings it was easier to forget.

Usually this is simply running away from a troublesome situation. It may help one to forget and for that reason it may be a good procedure where one must reconstruct his life after a particularly disastrous or tragic experience. It will, however, prove insufficient as a habitual means of escaping the difficulties of life. The person who finds himself unhappy in his home town and moves to a faraway place in quest of a more favorable life situation is likely to find about the same difficulties in his new abode. The habit of running away to new places as an escape from difficulties should be avoided. Emotional ruggedness will be developed only by facing painful situations courageously with constructive efforts to make the best possible adjustment to conditions as they are.

Daydreaming. Some persons flee from painful life situations by means of their thoughts. For older persons this is likely to take the form of memories of happier days. Youth is prone to indulge in daydreaming for escapes from hard reality to a more agreeable life situation created by fancy.

Imagination can be an excellent means of maintaining morale in troublesome times. The picture of prosperity just around the corner helped many to keep up their courage during the financial depression of the 1930's. Hope of a better world to come helped us to maintain our emotional equilibrium while the world was being torn to pieces by the worst war in history. Constructive imagination coupled with earnest effort to overcome the cause of unhappiness is an asset to mental health, but the habit of fleeing from reality by way of daydreaming is unwholesome. The danger lies in coming to rely upon the daydreams for satisfying experiences and failing to do anything about the real situation.

A certain amount of daydreaming will do no harm but excessive indulgence in it is usually a sign of some unsolved emotional difficulty.

A teacher should encourage a child who daydreams to excess to face his problem, and help him solve it if possible. An active effort to translate daydreams into real accomplishment will help to prevent them from becoming a source of maladjustment.

Rationalization. An escape from the distress of remorse from wrongdoing, of humiliation from failure, and of regret from mistakes is found by many persons in the practice of rationalizing. This appears in the form of excuse-making or self-justification for a matter of conduct which is incompatible with one's ideals or better judgment. It is employed to camouflage one's real motives or desires, to make unworthy ones appear respectable and frustrated ones of no account or unwisely entertained. As an example, we may take the case of a boy who steals money from a companion and then justifies his act on the grounds that he had to have the money, and that because his parents were poor he was doing them a favor by not asking them to give it to him. A student keenly disappointed because he was not invited to join a fraternity finds solace in thinking, "They are a bunch of snobs, and I probably wouldn't like them anyway." If he loses in the race for the presidency of his class, he consoles himself by thinking that class politics made the election unfair, the president has a lot of hard work to do for which he gets no thanks, and it really is a good thing he wasn't elected.

Rationalization is not always harmful. Everyone probably resorts to it at times. As a palliative for a broken heart, or a means of sustaining self-esteem in defeat, its use should not be entirely condemned. It is like taking a drug which deadens a pain but which does not remove the cause of the pain. The danger in habitual recourse to rationalization lies in the fact that it fosters self-deception in covering up one's true motives. Evasion and self-deception can never provide a permanently satisfactory adjustment. The facts must be faced squarely and acknowledged frankly if there is to be force of character and a wholesome, healthy personality. The practice of rationalization in children can be discouraged by letting them know that we see through their use of it. Children should be encouraged to face and admit their real motives.

Other forms of escape. Some other common evasive reactions in emotional conflicts are: doing or saying things to arouse the sympathy of other persons, projecting the blame for mistakes or misconduct on others, identifying one's self with a hero or person whose life and conduct reflect the fulfillment of one's frustrated ambitions and desires, and a dissociation of one's thoughts whereby incompatible motives are prevented from coming together in conflict.

Compensation. Frustration frequently leads to an attempt to adjust by compensation. Here the individual tries to make up for his failure or disappointment by taking some other course which he finds open. Thus, the student who finds it impossible to achieve recognition in athletics because of a physical handicap may turn with redoubled effort to literary activities in the hope of winning a place on the college debating team.

Compensatory activities may serve as wholesome emotional outlets. But they should be entered upon with a definite recognition that they are substitutes for the thwarted ambition and frankly accepted as the next best thing. They are likely to lead to further trouble if the individual is not aware of the motives which prompt them, if they are undertaken to spite another person, if they are detrimental to others or antisocial, or if, despite his efforts, the individual fails to derive substitute satisfactions.

Constant criticism of other persons is usually related to some kind of frustration. Spreading gossip, particularly that of a scandalous nature, gives some people a sense of superiority and is usually a sign that they have not been successful in achieving self-esteem by more desirable means. Misconduct of children in the home, in the classroom, or on the playground is often the result of effort to secure satisfactions which they have failed to obtain in more acceptable ways. By creating disturbances, the child who feels that he has not received sufficient recognition becomes the center of attention. He compensates for a sense of inferiority by boasting and swearing, or by teasing and bullying other children. The teacher who can recognize the compensatory aspect of a child's misbehavior will be able to deal with it more wisely; for if undesirable behavior is the outgrowth of an unsolved emotional problem, its correction calls not for punishment alone but for a removal of the underlying cause.

Many conditions such as broken homes, poverty, low-grade intelligence, and bad community influences have been listed as causes of juvenile delinquency, but the fact remains that a great many children in these conditions do not become delinquent. Careful studies have revealed that the most universal factor behind delinquent behavior is some emotional problem which the adolescent has not been able to solve in a manner acceptable to adult society (7).

Adjustment by direct attack and substitution. Such evasive forms of reactions to emotional conflicts as we have been considering in this section are not conducive to permanent and satisfactory adjustment. In the interest of his happiness and mental health the child should be encouraged to face troublesome situations squarely and be taught how to deal with them in a wholesome manner.

In the case of opposition and frustration the most natural and wholesome method of dealing with situations is to make an attack directly upon the cause and remove it. Whether this will be possible or successful will, of course, depend upon the nature of the opposing conditions and the means employed to overcome them. If a child is emotionally maladjusted because of failure in reading caused by defective eyesight, having his eyes fitted with glasses and then giving him the required instruction in reading would be the indicated procedure. If a girl is suffering from the frustration of her desire for friends because she is too fat and untidily dressed, the best way for her to recover her happiness would be to regain her normal weight by proper dieting and to remedy the faults in her attire. If a teacher desires advancement and finds that her lack of a college degree stands in her way, the normal thing for her to do would be to take college courses leading to the required degree.

When the frustration is due to conditions which cannot be removed, one should accept a good substitute or make a constructive revision of his aims. If circumstances arise which make the projected vacation in Europe impossible one might, as a good substitute, spend a couple of weeks at the beach or take a short trip to the mountains. He should in doing this, however, admit that this is his second choice and not try to deceive himself by rationalizing. If a person finds himself torn between two desired but mutually exclusive courses of action, he should weigh the facts on both sides to the best of his ability, definitely select one and give up the other, and then refuse to worry about his decision.

The Emotionally Well-Educated Adult

Throughout this chapter we have attempted to show how emotional reactions are modified and developed through learning. It has also been our purpose to point out the need for training the emotional life and to suggest the direction which such training should take. The following paragraphs set forth the characteristics of an adult whose emotions have been well educated. The standard is high, and the reader should not be discouraged if he fails to measure up on all points. Few persons will. However, it may be noted that the intellectual education of most persons also has numerous depressions. The important thing to keep in mind is that these emotional characteristics can be cultivated, and an honest effort to develop them will pay dividends in serenity, efficiency, and mental health. This description of an emotionally well-educated adult represents an attempt to formulate a set of specific objectives toward which we may strive in the development of emotional maturity and stability both in ourselves and in the children and students who come under our direction.

Emotional stamina. The emotionally well-educated adult possesses emotional stamina. He withstands the emotional stresses of life. He is able to suffer disappointment without being overwhelmed by despair, to meet frustration without losing temper, and to face adversity without losing hope. He can submit to legitimate restrictions without humiliation or abasement of pride. His courage and determination to press forward hold firm through sorrow and deprivation.

Emotional attitudes. He subjects his desires, prejudices, likes and dislikes, and feelings of guilt to the critical light of reason. For him, there is never a serious conflict between judgment and desire. He avoids irrational transfers of his emotional reactions, and refuses to be governed by a childish conscience. His fears are based on an understanding of the natural sequence of cause and effect. He is less angered by personal affronts than by social injustice. His behavior is not motivated by spites, and his ambitions are not ruled by vanity.

Loyalties. He is loyal to his friends, to his employer, and to the institutions upon which his happiness and welfare depend. He does not condone their faults nor merely condemn them, but does what he can to correct them. Distinctions of loyalties are determined by an intelligent discrimination of rights and merits; he renders "unto Caesar the things that are Caesar's; and unto God the things that are God's." (St. Matthew, 22:21.) He avoids confusing conflicts by subordinating minor loyalties to major ones. When his affiliations change, he is able to transfer his loyalties to accord with the new circumstances of his life.

Self-reliance. He is self-reliant and assumes the responsibility for directing his own life. He thinks for himself, and makes his own decisions. He is self-confident without conceit or undue modesty, and self-respecting without a sense of self-importance. From others he expects justice and respect but not obeisance.

Direction. He has a purpose in life toward the realization of which he directs his attention and efforts. Through purposeful striving he avoids being a drifter and escapes the stifling effects of living in the past. In the establishment and pursuit of his goal he is courageous but not foolhardy. He weighs the possibilities of achievement and tempers his aspirations by understanding. He is guided by a discerning sense of values. He does not allow wishful thinking or daydreaming to become a substitute for positive action. For him, difficulties encountered are problems to be solved. He shuns self-pity, for he knows that it is a form of self-imposed weakness.

Advancement. For him, life is progression, a moving forward, improvement, enrichment of interests, cultivation of understanding, and advancement to higher levels of achievement. He desires success and works to that end, but for him success lies in doing his best, not in outdoing others. He seeks to make the best possible use of his talents and opportunities, and in his efforts to do so is undaunted by obstacles and impediments. He accepts an honest appraisal of his abilities and disabilities, and endeavors to make the most of his strong points. He strives to remove handicaps which can be eliminated and to correct deficiencies which can be remedied, but accepts the inevitable with fortitude. He refuses to worry or to blame himself or to suffer the pangs of an adolescent inferiority complex because of conditions over which he has no control. He is honest with himself and seeks to discern his true motives. He does not deceive himself by rationalization, nor does he try to conceal his mistakes and weaknesses from others by blustering, boasting, or making excuses.

Realistic attitude. He faces life squarely and does not flee from hard reality into an easier world constructed by his own fantasy. He does not belittle his opponents nor underrate them. He is able to take criticism without resentment or weeping, and without the invention of excuses to deflect it. He considers its source, weighs it with an open mind for the truth it may contain, and seeks to profit by it. He is not crushed by criticism which he honestly believes is not just. He avoids the childish practice of projecting on others the blame for his own shortcomings. He makes no pretense of perfection.

Tolerance. In his relations with his fellow men he is tolerant, sympathetic, and courteous. In judging others he considers their abilities, emotional traits, and motives. He does not expect the same from all persons, but makes allowances for age, fatigue, ill health, ignorance, and special weaknesses. He is mindful and considerate of the rights of others. He is courteous without surrendering his convictions, and kind without being obsequious. He respects an honest difference of opinion.

Responsibility. He is willing to assume responsibility and does so with courage. He expects to pay his own way, to give as well as to receive, and to carry his just share of the common social burdens. He finds satisfactions in contributing to the happiness and welfare of others. He accepts the social obligations of love as well as its pleasures. He loves his children, but he does not pamper them; nor does he regard them as possessions to be exploited, to inflate his own ego, or to enhance his own vanity. He seeks to develop in them self-reliance and independence.

Maturity. He is able to say, "When I was a child, I spake as a child, I understood as a child, I thought as a child: but when I became a man, I put away childish things. . . . And now abideth faith, hope, charity, these three; but the greatest of these is charity." (I Corinthians, 13:11, 13.)

Summary of the Chapter

Properly developed emotional reactions are essential to mental health, happiness, social adjustment, and a wholesome personality. Emotional activities are complex functions which involve visceral and skeletal behavior and emotional experience. An emotion starts with perception of a predicamental situation, and runs its course through the affective seizure, efforts to resolve the difficulty, and a gradual recovery from the disturbance. In violent emotions the individual is frequently unable to react in an adequate manner, but sometimes a well-fixed action trend withstands the shock and the action is carried out with unusual promptness and energy. The secret of avoiding the devastating effects of panic is to have an adequate form of response prepared before the emergency arises.

The complex emotional activity we observe in children and adults develops from a set of reactions in infants which reflect not clearly differentiated emotions but a state of excitement. Outward behavior is not a reliable indication of the character of the emotion. We judge one's emotions largely by what we know of the provoking situation.

As one grows from infancy to maturity, his fears change. The child acquires new fears through conditioning and from threats, suggestions, and imitation. The development of understanding causes the elimination of some fears and the appearance of new ones. Sometimes childhood fears persist into adult life. Some fears of children are traceable to unfortunate remarks and unwise methods of the teacher. The child tends to disguise and conceal his fears as he grows older. The teacher should avoid practices which instill fear, and assist the child in overcoming persistent fears. Effective methods for overcoming fears are: verbal assurance coupled with an example of courage, introducing the fear object by degrees in a pleasant situation, and the development of adequate responses for coping with the situation which arouses fear.

Anger is caused by interference and frustration. The situations in which these appear change with growth in experience. Under social pressures the behavior in anger tends to become more restrained. The other emotions are also modified through learning.

Mental health depends largely upon good emotional habits. Special opportunities should be provided for handicapped children, schoolwork should be suited to the child's ability, and discipline should be consistent. The child should learn to face his emotional problems realistically. Such escapes as running away, daydreaming, and rationalization should not be allowed to become habitual methods of reacting to difficulties because they do not solve the problems, and sometimes lead to further troubles. A direct attack upon the source of the difficulty is usually the best way to resolve an emotional conflict, but in the case of unsurmountable obstacles, a shift in aims is desirable. Misconduct is often compensatory behavior produced by frustration.

The emotionally well-educated adult possesses stable and mature emotional habits which are in harmony with his intellect, coördinated with his behavior, and in accord with the happiness and welfare of other persons.

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Chapter XVII

THE DEVELOPMENT OF ATTITUDES AND IDEALS

Learning is the development within the individual of controls and determiners of behavior. As these controls are changed, the individual's behavior takes on new forms. Thus, the modification and control of behavior is the outcome of learning. Among the various tendencies and predispositions which are acquired and modified by learning none is more important to individual and social welfare than attitudes and ideals. These determiners of activity are important because of the broad scope of their potent influence. They extend beyond the range of habit, and they govern the use of knowledge. Their development is more difficult to manage and to appraise than is the development of skills and knowledge, but it is equally essential for the full and wholesome education of the individual.

ATTITUDES

We have had occasion to refer to attitudes several times in preceding chapters. They were mentioned in connection with the outcomes of educational training as a generalized form of control of behavior. They were presented as a form of set in the chapter on motivation, and their influence as a factor in conditioning was discussed in chapter VII. In the previous chapter brief mention was made of emotional attitudes.

There are many different connotations of the term *attitude* as it is used in the literature on the subject (3). It is used to mean almost any form of set from organic urge, bodily posture, or habit, to purposes and ideals. This loose and varied use of the term simply means that a common definition or conception has not been universally adopted. G. W. Allport (1*a*), after sifting many definitions of *attitude*, finds certain points of resemblance from which he presents the following statement, "An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related." A state of readiness for certain forms of response is what we have called *set*. There are several different kinds of readiness or set. In our discussion of the subject in chapter VI we mentioned organic needs, social motives, habits, tasks, problems, attitudes, and ideals.

The task, as we use the term, involves purpose or intent with foresight of a specific goal. The ideal is similar except that the goal is broader and more general. The distinction is one of degree regarding the broadness and scope of the goal. A continuum of partially generalized purposes intermediate between them makes a sharp demarcation impossible.

Upon repetition task-controlled action becomes habituated. The task gradually drops out and habit set assumes control. But there are various degrees of habituation, which means that between task and habit are intermediate or partially habituated sets.

Likewise, attitude differs from ideal in that conscious purpose or foresight of goal has dropped out. But it does not drop out all at once. As an ideal is practiced, a gradual transition from ideal to attitude takes place. Hence, there are intermediates here just as there are partially formed habits. The distinction, therefore, between ideals and attitudes is a matter of the degree to which one has ceased to think about his general goal.

Attitudes, then, are like habits in being states of readiness without conscious purpose or intent. But they differ from habits in the wider scope of their control. The effective range of habit is limited, as is the task, to a relatively specific or particular form of response, while attitude is a directive set which may operate in widely differing situations and which promotes various forms of behavior. But there are partially generalized tendencies, which fall between the typical habit and the typical attitude. By attitudes we mean relatively generalized determiners of activity.

Habits, attitudes, and ideals are all, moreover, relatively permanent sets. They remain after the activity which they determine has been completed. In this respect they differ from tasks and problems, which disappear when their respective goals are reached.

"Three fundamental attitudes." Bentley (7) describes three fundamental attitudes which persons assume toward objects and other persons. These he calls the attitudes of *"knowledge, appreciation,* and *use."* The attitude of knowledge is one of seeking to know or to understand. The attitude of appreciation is an evaluating attitude. We assume it toward things we regard as beautiful or ugly, or as sources of pleasure. The attitude of use is the practical or utilitarian attitude. It is the attitude we have toward something we regard as a tool or as a means to an end. We may have any one of these three attitudes toward the same object at different times. Take your fountain pen for example.

When you inquire concerning its manufacturer, its age, the materials of which it is constructed, and the operation of the filling device, your attitude toward it is that of knowing. If you admire its beautiful coloring, appraise it as an unusually fine pen, or regard it as a treasured reminder of a dear friend from whom you received it as a gift, you are taking toward it the appreciative attitude. When you regard it as a tool for taking notes and writing letters, your attitude is utilitarian.

In the well-balanced individual all three of these attitudes take their rightful places in properly distributed proportions. If one is magnified at the expense of the others, we find a distorted or lopsided personality. In the pedant the attitude of knowledge takes undue ascendance over appreciation and use. The sentimental person has an exaggerated appreciative attitude, and in some hardheaded businessmen dominated by the attitude of use there is found little artistic appreciation and a tendency to belittle learning.

The curriculum of our schools makes due provision for each of these major attitudes. The sciences represent the attitude of knowledge; literature and the fine arts, the attitude of appreciation; and the vocational studies and applied science, the attitude of use.

Scope and versatility in attitudinal control. It will be readily seen that the attitudes mentioned above exert a directive influence on the manner in which one responds to a great variety of situations. The way one thinks, feels, and acts is determined largely by the dominant attitude at the moment. A person who has a strongly developed scientific attitude, for example, finds satisfaction in scientific research, though the collection and testing of data may take many different forms. He thinks in terms of cause-and-effect relations, and is desirous of discovering the explanation of various phenomena and the influence of certain conditions. He is annoyed by violations of scientific procedures in the collecting and interpretation of data.

A boy who has a well-generalized coöperative attitude will be quick to notice situations calling for coöperation with others and will derive satisfaction from being coöperative. At camp he will cheerfully gather firewood, peel potatoes, carry water, or help pitch the tent. At home he will clean the mud off his shoes before entering the house, shovel the snow off the walk, help wash the family car, assist in taking care of the furnace, move about quietly when others are sleeping, and keep his room orderly. At school he will take part in the extracurricular activities and obey regulations. If this attitude is only partially developed, the boy may be coöperative in some of these situations and not in others.

The situational range of an attitude is frequently more restricted than it is in the cases just mentioned. One may have an attitude, for example, which operates only with respect to a particular object, or person, or even with respect to some trait of a particular person, such as a dislike for his profane language or untidy appearance. But even here there is a flexibility or variability of response not found in habit. If such flexibility is not characteristic of the predisposition, then it is a habit according to the distinctions we have made here.

Some writers have held that attitudes are specific both with respect to situations and to responses. Such a view is based on the findings that the behavior reflecting certain character traits is inconsistent. For example, in the case of honesty, a child is sometimes honest in one situation but not in others (23). Granted that there are different degrees of generalization with respect to attitudes and that in young children there may be specific habits instead of generalized control, the case for the generalized character of attitudes seems to this writer more convincing than the arguments for specificity. It is, as we see it, when habits broaden in scope and become integrated into a generalized disposition that we have an attitude (1*b*).

Attitudes and personality. An individual's personality includes his attitudes but it also includes traits. The distinction between traits and attitudes is not always clear-cut but in general the attitude involves a fairly definite reference to things or ideas and usually is a disposition to react favorably to or against the object of reference. Traits have less definite reference and have more to do with one's manner of adjusting himself to widely differing situations. G. W. Allport (1*c*) makes the distinction as follows: "A trait, in short, is a man's personal and unique manner of responding to the myriad circumstances of life; it has very little reference to objects, for innumerable objects will arouse it. An individual's point of view toward war, liquor, the church, or capital punishment are clearly attitudes and not traits, but his talkative, shy, or emphatic *manner* of behaving are traits. The former are clearly less intimate and less personal than the latter."

Attitudes and social life. The object of reference in attitudes is not always social, but there are so many attitudes which refer to other persons and social issues that the character of an individual's social life is to a large extent identified with the type of attitudes which have been established in him. Therefore, the social education of the child calls for the engendering of desirable social attitudes and the elimination of undesirable ones. Friendly, coöperative, and judicial attitudes are to be fostered, as also are loyalty to school, home, church, and the government. Racial prejudices, born of ignorance and stereotyped modes of thinking, beget hatreds, unhappiness, and injustice. They should be prevented from growing and eliminated so far as possible. Other attitudes which are incompatible with social harmony and welfare are hostility to authority, class antagonisms, religious prejudices, and "the-world-owes-me-a-living."

A survey of the case histories of delinquent youths and criminals reveals that unwholesome attitudes are responsible in a large measure for their misdeeds (19, 22). This fact indicates that for an effective program of re-education or reform effort should be primarily directed toward the correction of faulty attitudes. Such a policy differs from that of attempting to reform the individual by improving his habits. The training of proper habits is good as far as it goes, but since the functioning of habits is limited in scope, such training is insufficient to insure socially desirable conduct in the situations for which habits have not been developed. It would be impossible to establish habits for every possible life situation. It is true, as we have seen in the experiments on conditioning, that a response trained to one situation may spread or transfer to other situations that are similar. This, we have seen, is particularly true of emotional responses. Also, a habit tends to become general and to approach the status of an attitude if it is practiced under a variety of situations. But to reform an individual through the development of a sufficiently elastic set of habits would be a slow and laborious process. At best we may expect situations to arise for which the individual has no ready-made response of the habit type, and then, unless we have changed his outlook as a whole, the old tendencies may express themselves in unsatisfactory behavior. We need to develop controls which regulate whole systems of responses for various types of social situations. With the development of adequate generalized controls directed toward socially desirable forms of behavior the faulty habits will tend to disappear under the opposition of the new trends (17).

An example of rehabilitation by changing attitudes may be seen in the program of a state reformatory for women which has an excellent record for restoring its "students" to a suitable place in society. The women committed to this institution have been found to possess the following destructive attitudes: distrust for persons in authority, desire to injure others based on antagonism due to injustice experienced or some injury received, the desire for profit without effort, and a feeling of hopelessness. To restore these individuals to normal social living an effort is made to eliminate these attitudes and to build in their place the following constructive ones: confidence in authority, by concrete acts of helpfulness, and close community contacts with the officers of the institution; a sense of responsibility, by means of definite tasks; an attitude of coöperation, by means of clubs and other group activities; an attitude of compassion, by just treatment and an example of kindness; and confidence in ability to cope with life, by training for a trade or skilled occupation (49).

We are living in a world of rapidly changing social conditions. Old procedures and old solutions are inadequate to cope with the new problems which the changing order presents. The younger generation cannot be prepared to face the future demands to be made upon it by our developing in them fixed patterns of response based on past or present conditions. Our young people must be trained to make readjustments and adaptations while holding fast to the fundamental principles of democracy which we cherish. The problems of government, finance, industry, and international relations will be a challenge to their versatility and resourcefulness. Changes will inevitably come, and there must be a readiness to adjust to them. If social change is not to outrun our democratic processes the school must instill in the young certain democratic attitudes and ideals. These, if developed, may be expected to direct creative effort along the lines of a democratic order.

Reports of studies made of the attitudes of school pupils indicate that our schools have not been particularly successful in instilling democratic attitudes. The findings indicate that a large proportion of the young people are possessed of prejudices and views which are not in keeping with democratic principles. For example, H. E. Jones found that sixty-two per cent of the first-year pupils of a favorably situated high school expressed a dislike for all radicals, sixty-five per cent agreed that foreign radicals should not be allowed to visit the United States, and seventy-one per cent would not allow radical agitators to speak publicly in parks and streets, while twenty-four per cent supported the statement that armies are necessary in dealing with backward peoples (24).

Democracy cannot prosper in a nation whose people are heavily loaded with religious and racial prejudices, and class hatreds and antagonisms. Education for democratic citizenship calls for the prevention and removal of such inimical attitudes and the establishment of such favorable ones as:

1. Belief in the "inalienable rights" of the individual.
2. Acceptance of the principle of equality of privilege.
3. Tolerance of the views of others and a willingness to allow these views to be expressed.

4. Respect for the individuality of other persons.
5. A willingness to accept social responsibilities.
6. A willingness to abide by the decisions of the majority.
7. A willingness to arbitrate conflicts of interests.

Studies of Attitudes of Children and Students

Many studies have been made to determine the nature of the attitudes of children and students. These studies have dealt with a large variety of subjects, such as racial preferences, views on various social issues, preferences for school subjects, and attitudes toward God and the church. No attempt is made here to summarize all this literature. A few studies are mentioned briefly for the purpose of illustrating the character of the work done in this field.

Racial preferences and prejudices. Beckham (5), in a study of a large number of Negro adolescents, found that by the age of twelve most of them had experienced some form of unfavorable discrimination or humiliation because of their race. The effects most often produced were resentment, aloofness, antagonism, and in some cases a strong desire for personal achievement. A majority thought white teachers were usually fair, but a number complained that teachers showed discrimination in favor of white children in grades, positions of leadership, seating, sympathy, derogatory remarks about Negroes, and in discouraging the Negro pupils from taking part in extracurricular activities.

A study of the racial prejudices of college students by Katz and Braly (29) showed the Americans and English to be the most favored groups. Next in order of preference came the Germans and Irish. Below these came Italians and Jews, while the Chinese, Negroes, and Turks were assigned to the least favored positions. The conclusions of this study, which are in general agreement with those of a number of other investigators, are that racial prejudice "is a generalized set of stereotypes of a high degree of consistency which includes emotional responses to race names, a belief in typical characteristics associated with race names and an evaluation of typical traits."

In a comparison of racial preferences of colored and white children in St. Louis, Meltzer found that the Negro was ranked first by the colored children and twentieth by the whites. The Japanese, Mexicans, South Americans, and Chinese were more favored by the Negro children than by the whites, while the Germans, Poles, Swedes, Jews, Scotchmen, and Greeks were less favored by the Negroes (33).

By means of personal interviews a study was made of racial prejudice as it applied to 162 Italian-Americans. Fifty-seven per cent of this group stated that they had been subjected to some form of prejudicial discrimination because of their nationality. Practically all of these had experienced discrimination before the end of the period of adolescence. The children and adolescents seemed to be more distressed by the alleged discriminatory treatment than their elders. The most frequent emotional responses to such treatment were said to be anger, resentment, and hate (30).

In general, it can be said that adolescents are inclined to have rather strong racial prejudices and that the effect of such attitudes is ill feeling, the withdrawal to itself of each racial group, the termination of social contacts, and the development of a persistent antagonism. The mingling of pupils of the various race and nationality groups in the classes and in the extracurricular activities of the public schools should do much to prevent or overcome these unwarranted antagonisms, provided, of course, that the teacher sets an example of just behavior.

Subject and reading preferences. The results of a questionnaire study made by Blair (8) of the subject preferences of 1,463 students in a senior high school indicated that the subject most preferred by mentally superior boys, those with I.Q. above 113, was mathematics. For inferior boys, those with I.Q. below 95, shop was the most liked subject. The preference of the superior girls was English, while the favorite of the inferior girls was home economics.

From the findings of Rothney and McCaul (41) in an investigation of the free reading choices of high-school boys it appeared that the teaching of literature had not established a liking for the types of reading material used in the English courses. The boys in the study preferred newspapers and magazines to books. The magazines they liked best were the comic, scientific, news, and boys' publications. Others for which a preference was indicated included those devoted to popular fiction, the radio, movies, and detective stories. The most favored books were the ones which contained stories of adventure, the sea, and mysteries, and those which dealt with sports and vocations. Suggested reasons for this poor taste in reading matter were: the poor choice of selections studied in English courses, the disregard of the pupils' current interests, and poor teaching.

Various studies have shown that the reading interests of boys and girls differ somewhat both in childhood and in the adolescent period. Boys, for example, in the elementary school years are likely to be most interested in reading about war, atheletics, and adventure, while girls like fairy tales and stories dealing with home or school life. Girls become interested in romantic novels earlier than boys. In adolescence they favor love stories, and reading that deals with travel and home life. Boys of the adolescent age generally prefer such subjects as sports, outdoor life, adventure, inventions, and machinery (28).

Religion and the church. The results of an investigation of students' attitudes toward God and the church at three large universities and three denominational colleges indicated that few students were inclined to be atheistic. There appeared to be no important differences between the attitudes of the two sexes and little change in religious attitudes during the four years in college. The attitudes of the students in the denominational colleges were somewhat more favorable than those of university students (21).

By means of a questionnaire Dudycha (14) obtained an expression of religious beliefs from 852 college freshmen at the beginning of their first year in college and from 305 college seniors just before graduation. Each student was asked to indicate the nature and extent of his belief for each of twenty-five propositions concerning matters of religion. The freshmen showed a somewhat greater tendency toward wholehearted belief than did the seniors, but the majority of the latter indicated that they still believed most of the fundamental doctrines. Belief in the existence of God was expressed by ninety-six per cent of the freshmen and by ninety-three per cent of the seniors. There were more disbelievers than believers among the seniors only in the propositions pertaining to the existence of hell, angels, the devil, present-day miracles, and the creation of the world in six solar days.

Social and economic questions. Young adolescents are generally rather conservative with respect to sociological matters, and the tendency is for them to become more liberal with increase in knowledge and personal experience with the issues. A number of studies have thrown light on the attitudes of youths relative to social and economic problems. In regard to such issues as prohibition and communism adolescent attitudes differ to about the same extent as those of adults and probably reflect the opinions and feelings of the older persons with whom these young people are associated.

One study, the Maryland youth survey, through interviews with many hundreds of young people between sixteen and twenty-five years of age, showed that a very large majority favored government work relief and a smaller majority were in favor of the government's fixing minimum and maximum wages. Nearly half of the number were opposed to any form of child labor, while about a third would condone it if the family needs the financial help. More than half thought that war was needless and preventable. Among the employed youth there was a large proportion who felt dissatisfied with the wages they received, and the number who felt they were not paid what their services were worth tended to increase between the ages of sixteen and twenty-four years (6, 40).

War. During the years before World War II a large number of studies were made of the attitudes of high-school and college students toward war. In practically all of these where definite scores were obtained by means of attitude scales, the mean scores for both men and women fell in the divisions labeled "mildly pacifistic," "strongly pacifistic," or "moderately opposed to war." The women usually were found to be slightly more pacifistic than the men. In a number of cases the same students were retested later in their course to discover whether there were shifts in their attitudes. In some cases there were shifts by some individuals toward greater pacifism which were offset by shifts of others in the opposite direction leaving the mean score of the group about the same (15, 16). But several retest studies indicated a small but definite shift toward greater pacifism (12, 18, 26, 27, 42).

With the outbreak of war in Europe there was some indication of a shift away from the pacifistic attitude. Then came the Pearl Harbor attack and our entry into the war in full force. Students who had been taught by the school, the church, the radio, the movies, and the press to regard war as a horrible thing and futile as a means of settling disputes between nations—students who had acquired from their teachers, parents, and pastors attitudes which set them against war—were suddenly told that they must become soldiers, fighters, and killers because arbitration and conciliation had failed. The result was confusion, doubt, and disillusionment. The emotional shock to many was great.

It was not easy to embark on a course absolutely opposed to one's deep-seated feelings and convictions. But social pressure and law made it practically impossible to do otherwise. High-pressure propaganda, fear of consequences if the war were not won, and war hysteria did much to make over the feelings and opinions of many. Others, not being able to escape from years of training, entered upon their duties with resentment against war, but sustained by an urgent desire to get the "dirty mess" over as soon as possible, a faith in the possibility of an enduring peace, and confidence in their ability to manage in the future the affairs of the nation more successfully than their elders had done it.

How Attitudes Are Acquired

Attitudes spring from a number of sources. Some of these are to be found in the classroom but many are outside of it. Since preparation for good citizenship calls for the establishment of the appropriate generalized controls of behavior as well as understanding, it is the responsibility of every teacher to contribute to some extent to the development of wholesome attitudes.

The school is certain to affect pupil attitudes. We should try to make that influence count in the right direction. This means that the development of attitudes and ideals cannot be left out of the teacher's aims and plans. Their development should be cultivated by design, not left to the hazards of growth as incidental by-products of classroom instruction. It is believed that long after the factual material of instruction is forgotten, the attitudes acquired through classroom experiences may continue as potent factors in the life and behavior of the individual. The teacher should be sensitive to the attitudes possessed by his pupils, should know the ones required for good citizenship and individual happiness, and should strive to eliminate wrong ones and to engender the desirable ones. We mention here some of the ways in which new attitudes arise.

1. **Imitation.** In many cases a person simply adopts attitudes of his associates. In the case of young children particularly this is likely to occur without any definite awareness of the attitude and without realization that it is being assumed. This is often the case with certain religious attitudes which a child takes on in early years through home influences. It may be true also of racial or class prejudices, political attitudes, and preferences for certain types of food or music. The adolescent is inclined to conform to his group. He notices their prejudices, likes, and dislikes and copies them in order to be like the others. Adults also frequently take on uncritically the attitudes of the group to which they belong.

2. **Emotional experiences.** Attitudes, particularly likes and dislikes, attractions and aversions, interests and antagonisms, are often traceable to some strong emotional experience or to incidents or associations of a definitely pleasant or unpleasant nature. Humiliating or unjust treatment may set up in a child a resentful attitude toward the parents or toward the teacher from whom it was received. A timid attitude may result from a series of frights. An appreciative attitude toward good reading matter is most likely to be developed in the child who enjoys his literature class. So strong is the tendency for one to

assume a favorable or unfavorable attitude toward persons or things associated with a pleasant or unpleasant experience that the process through which such attitudes are established appears to be a form of conditioning.

A little girl who had a sore mouth tried to eat some candy. It caused her much pain and she never cared for candy afterward. A teacher writes, "As a child, I spent a summer vacation with an aunt who had no children and, I suppose, didn't know what to expect of a child of my age. She believed that every girl must be a good sewer. I had done some very simple sewing before, more in the way of play than anything else, but she gave me things to do that really were too difficult for any child of my age. Naturally, I had a very hard time trying to do what she told me to do, to say nothing about sticking the needle into myself often. Invariably what I did turned out badly and I was reprimanded severely for it each time. The effect of that has always stayed with me. Even to this day I hate sewing and never do any unless it is absolutely necessary. That one summer's experience destroyed any desire on my part to sew, although I had previously enjoyed making dolls' clothes, even though they were not great successes. Another and far more serious effect was that I took a dislike for that aunt and never wanted to visit there again."

The writer's father once remarked, "You never hear of parents naming their son Nero. Paul is a favorite name for boys, but Nero makes a good name for an ugly bulldog." In the writings of St. John appears this sentence, "But this thou hast, that thou hatest the deeds of the Nicolaitanes, which I also hate." (Revelation 2:6.) Most of us do not discriminate in our hates, or likes and dislikes, between a person and his deeds. We like a person if we like what he does, we hate him if we find his behavior offensive.

Falling in love with a person at first sight may be due to some trivial association wholly unworthy of the grave results it produces. If a girl is very fond of her father and the father wears a mustache, she is likely to have a predilection for young men who wear mustaches. If a few college boys behave badly on the streets, their actions turn the townspeople against the whole student body. If an actress plays the part of a despicable character, there is danger that the audience will not appreciate her superb performance in their disgust for the character she portrays. If the child has a bad time with his arithmetic, he tends to dislike the teacher, or if some disciplinary action by the teacher arouses his resentment, he may dislike not only the teacher but also the teacher's subject. It has been found that the subjects which high-school students say they like the best are the ones taught by the best-liked teachers (13). A young child was experimentally made to dislike orange juice, which before the experiment he liked, by repeatedly putting in his mouth by means of a dropper a squirt of vinegar after four to six squirts of orange juice (34).

3. **Informative experiences.** Attitudes are also built up by means of many different forms of experiences which add to one's fund of information or which change one's impressions. Such experiences include what we are told, what we see, and what we read. The information may be true, it may be a distortion of the truth, or it may be wholly false. It may affect our attitudes directly, or by way of suggestion. It may be derived from a lecture, sermon, or conversation; from the radio, movies, newspapers, or magazines. When we learn that one whom we have regarded as a friend has been making derogatory remarks about us, our attitude becomes one of distrust. Gratitude changes to resentment when it is discovered that someone has done us a favor only to place us under obligation for his own selfish purposes. Reports of corrupt practices by politicians destroy the confidence of the public in its elected representatives. Rumors of wasteful expenditures by the government make for resentment against a mounting tax rate. Sneers at the incompetence of "brain trusters" give the general public the impression that all college professors are visionary and incapable of thinking in practical or realistic terms. Malicious gossip destroys confidence and respect for one's neighbors. Accounts of the unprovoked invasion of a peaceful nation set us against the ruthless aggressor and arouse sympathy for the oppressed. Movies which play up the sordid aspects of war make us more pacifistic, while those which portray its glories, or which picture it as a heroic crusade against aggression or a patriotic enterprise necessary for national survival incline us toward a militaristic position. Clever propaganda, true or false, is effective in turning a peaceful, war-hating nation into one eager to fight. Derogatory remarks by a teacher about other nationalities or races tend to beget racial prejudice and a false sense of superiority of one's own race. Thus, we are led to favor or to oppose, to sanction or to disapprove, to admire or to hate, according to the type of information which comes to us. For just attitudes we must strive for the truth.

4. **Deliberate cultivation.** Attitudes may be deliberately cultivated. A person, for example, may cultivate in himself a friendly attitude toward his associates. The process is about the same as for the establishment of a habit. To build a new habit one starts necessarily on the level of purposive action. Through practice the task disappears

and the individual's behavior comes to be determined by his habit tendency. To establish an attitude by design one must practice the appropriate behavior in all the varied situations to which that attitude should apply. His purpose, being broad in scope, will be in the nature of an ideal. So for the friendly attitude he begins with an ideal of friendliness. By constantly being friendly with all his associates in all types of situations and through various kinds of friendly acts, he will reach the point where the general tendency to be friendly takes control and he does not each time have to think to be friendly or how to express his friendliness. If the individual is strongly prejudiced against a particular race and he regards that attitude as undesirable, he can overcome it by making a practice of always treating members of that race in just as fair a manner as he treats those of his own race, making no unfair discrimination and granting to them the same privileges.

In seeking to build an attitude by deliberate choice one will do well to observe the rules for habit formation laid down by William James. He should start with a strong determination, carefully considering the values of the attitude as a means of motivating his effort; not allow any exceptions to occur; and take advantage of every opportunity to act upon his new resolution.

We should be critically aware of our attitudes and guard against taking on those which will prove detrimental to happiness and social harmony. A good way to check on the soundness of an attitude is to consider what kind of people possess it, what kind of behavior it promotes, and what its effect is on the persons who hold it.

An attitude based on ignorance or misinformation is not to be trusted. Our attitudes on social, political, and economic questions should be formulated only after careful study and in the light of the best information available. The sources of our information should be carefully considered. If our informant is too emotional in his defense or attack, if he is strongly biased, or if he has a personal advantage to gain, we may well discount his reports or arguments and look for the facts on the other side. The study of history will help us to appraise current issues, and an understanding of the subtle ways of propaganda will fortify us against becoming its helpless victims.

THE MODIFICATION OF ATTITUDES

Classroom instruction. There has been in recent years considerable interest in the possibility of changing and developing attitudes of children and students in the school situation, and in the procedures by which this can be accomplished. In a study reported by Manske (31) it was found that the pupils' attitude toward the Negro tended to become more liberal with ten non-indoctrination lessons about Negroes. The attitude of the teachers seemed to have little effect on the changes produced by the lessons.

That it is possible to shift attitudes of pupils in a desired direction by means of suitable instructional material has been shown by a number of studies. In one, for example, the attitudes toward certain rural social problems were modified in the desired direction through class discussion of specially prepared material dealing with the problems (32). In another the attitudes of high-school pupils toward social insurance, capital punishment, and labor unions were shifted in the direction desired and for which the instructional material was designed. As indicated by tests given before and after the instruction, the pupils became more favorably disposed toward social insurance and capital punishment, and less favorable toward labor unions (4). In a study of the superstitious beliefs of junior-high-school pupils and the effect on these beliefs of a course in general science, it was found that the regular science work had little effect in reducing them, but special instruction designed for that purpose did decrease superstition (51). It has been shown that musical interest may be increased by suitable musical training (47). The measurement of the attitudes of a group of college students toward the treatment of criminals before and after taking a course in criminology showed a small shift away from punishment of criminals and respect for law, and a shift in the direction of capital punishment. Similar changes were found in the case of members of a class in sociology (43).

Remmers (37) measured the effect of a lecture on the League of Nations and found that for 180 college freshmen the lecture produced a significantly more favorable attitude toward the League. This investigator also in an interesting experiment on the retention of attitudes found that a change in attitude toward certain agricultural problems which resulted from fifteen minutes of instruction was still much in evidence after one year (38).

College. An extensive investigation of attitudes of college students toward war, the Negro, religion, and the church has been carried out by Jones (26). His work included retesting to discover changes in the attitudes during the four years in college. He found that both freshmen and seniors were, generally speaking, neither strongly conservative nor strongly radical. The differences between the freshmen and the seniors were small. From a position of moderate liberalism in the freshman year there was a tendency to become somewhat more liberal with advancement to the upper class levels. A very small correlation was found between intelligence and liberalism. Among the seniors the majors in natural science appeared to be the most liberal, while history and geography majors were the most conservative, although the differences were not large. Among the political groups represented the Communists were the most liberal, and of the religious groups the Jews were the most liberal. The groups which were most liberal at the beginning of their college course showed less change in the direction of greater liberalism than did the ones which were more conservative at the freshman level. The tests indicated that the students were not conservative or liberal in the same degree in the various fields, and that a change in one area does not necessarily mean a corresponding change in general or with respect to the other fields studied. The author of this study points out that specificity and generality are matters of degree and that in training for attitudes we cannot assume that if we secure improvement in one area there will be a general spread to all areas of experience. To secure generality in attitudes training must be directed toward generalization (cf. 20).

While there is ample evidence that the attitudes of students do change during their college life it appears that attitudinal objectives have not in most cases been clearly formulated. Catalogues of colleges have been found to mention most often religious and spiritual objectives. One study revealed that only about half specified intellectual excellence, and good citizenship was mentioned by less than a third (35).

Home and community influences. Many factors of home and community life serve to shape the attitudes of children and young people. Measured results have shown that motion pictures are sometimes effective in bringing about significant changes in attitude toward the subject of the pictures (36). The prestige of the majority is a potent influence. In one study it was found that after a presidential election more students indicated a preference for the winning party than before the election (50). An investigation by Breslaw of the factors determining political attitudes led to the conclusion that the most important influences were those of the home and of the individual's social life. These appeared to outweigh books and intellectual factors (10).

Failure. Failure is a fertile source of a number of unwholesome attitudes. Among these are to be found defensive attitudes; the tendency to withdraw from social life and to avoid difficult tasks; feelings of inferiority, discouragement, hopelessness; the conviction that there is no use in trying; and sometimes a smartness manifesting itself in annoying compensatory behavior. Treatment which has proven effective in overcoming detrimental attitudes brought about by failure includes encouragement, the removal of the child from overwhelming competitive situations, a convincing demonstration of the possibility of success by means of tasks suited to his ability and interests, and a liberal application of praise and recognition for his efforts and achievements.

Physical defects. Physical handicaps or defects sometimes produce unfavorable attitudes. They have been found to be a frequent cause of feelings of inferiority. A child teased because of his freckles, crooked nose, or cross-eyedness, or one who is laughed at because he is too fat or too thin, may develop a painful sensitiveness concerning his deviation or a belligerent attitude toward other children. If a child has a physical disability, he should not be placed in competitive situations where his handicap makes his failure inevitable. The irrregularity should be removed or corrected when possible. When it cannot be remedied, the child should be encouraged to accept his handicap bravely and taught not to use it as an excuse for evading legitimate tasks and responsibilities or for making other persons conform to his selfish whims.

Appreciation. Education should increase the individual's sources of enjoyment. Some persons have such a full appreciation of nature that they find rich satisfaction in the beauties which nature is constantly providing. They find pleasure in beautiful trees and flowers, in the color of the sunset, in the songs of birds, or the view from a mountain top; while other less fortunate souls indifferently pass these by because they have not learned to perceive nature as beautiful, as pleasing, or as something to be enjoyed. Likewise people differ in their ability to enjoy art, music, and good literature. What one enjoys is determined in a large measure by training and experience. The attitude of appreciation or enjoyment is, like other attitudes, developed through learning. The school can and should enrich the lives of its pupils by the cultivation of attitudes that predispose them toward appreciative responses.

Since we learn according to our reactions, we cannot expect an attitude of appreciation to emerge from classroom lessons that are dull and uninspiring, or from homework that is meaningless drudgery. If the child is to learn to like poetry, for example, he must find pleasure in hearing or reading the poetry studied in the classroom. The teacher's primary aim should be to help the child discover its beauty. Factors of knowledge or understanding which enhance the child's ability to perceive a particular poem as a thing of beauty may be expected to contribute to his appreciation; but since appreciation is so largely a matter of the feelings, the knowledge elements should be employed only as a means to the ultimate objective, which is not understanding but enjoyment. Undue emphasis on analysis and grammatical structure will defeat the real purpose. Too often the study of literature has missed its mark and has left the child with a dislike for rather than an appreciation of the kind of reading material used in the course. As one high-school pupil disconsolately expressed it when asked if he liked "The Rime of the Ancient Mariner," which he was studying, "Aw, all we do is to hunt for similes and metaphors."

The teacher's own attitude is important. He is not likely to succeed in training others to enjoy what he himself does not appreciate. But the teacher's appreciation does not of itself insure the adoption of his attitude by his pupils. We cannot expect, for example, the average twelve-year-old boy to find much pleasure in novels or poems that depend for their appeal on interest in romance. Not only should the teacher assign material adapted to age differences in ability and interests, but he should also be alert to the special current interests of children and tie up the assignments with them.

Attitude Tests

The attitudes of other persons are judged by behavior and expressed opinions. The appraisal of the attitudes of groups has been made more objective and definite by the development in recent years of a number of scales by means of which attitudes are rated quantitatively in terms of a score. In one type of scale a series of questions is asked and for each question a list of possible answers is presented. The answers are arranged to represent different degrees of approval or disapproval, acceptance or rejection, favorableness or unfavorableness toward the proposition or issue to which the question refers. They are presumed to represent both extremes and various intermediate positions and are assigned score values accordingly. The subjects tested are asked to check for each question the answer which represents their feelings, opinions, or most probable way of reacting (9, 11).

A series of scales for measuring attitudes on various social and economic issues has been developed by Thurstone and associates. In each scale a number of statements are presented. These statements vary from extremely unfavorable to extremely favorable toward the topic of the test. The score value of each statement is determined by combining the judgments of a large number of persons on the degree of favorableness which the statement implies. The individual taking the test is asked to check the statements which he accepts or with which he agrees. His attitude score is found by taking an average or median of the score values of the statements checked (44, 45, 46).

Such scales are based on the assumption that differences in attitudes toward a given matter lie in a continuum between two opposite extremes. Their usefulness, therefore, has been limited in the case of complex attitudes for which there may be a number of continua. In the case of the attitude toward war, for example, an individual may not have the same degree of favorableness or acceptance for different aspects of the problem. These scales have, however, been fruitful in locating the degree of approval or disapproval in general at a given time, and their reapplication has served to reveal shifts in the degree of favorableness or unfavorableness. All instruments of the questionnaire type for measuring attitudes are limited by the fact that they score only the subject's expressed opinion. Because of his own rationalization or his desire to be socially acceptable the subject's answers may not always be a reliable expression of his actual attitude or truly indicative of the character of his behavior.

Another approach to the estimation of attitudes is by way of scales for rating the behavior of children in various situations. In one of these, for example, appear thirteen situations such as commonly occur in the classroom. Under each situation is presented a check list of various forms of behavior. The child's score on the test is derived from the behavior items checked not by the child himself but by the person using the scale. The advantages of such a procedure in the case of young children are obvious (48).

IDEALS

As we have endeavored to point out before, there is no sharp line of demarcation between attitudes and ideals. The distinction, we believe, lies in the degree to which the generalized control of behavior is a matter of conscious direction, or the extent to which the individual has in mind the relatively broad goal of purpose. The ideal, therefore, involves an idea of an end to be achieved and a commitment of one's efforts to attain that goal. This commitment in the form of purpose or desire is a form of set or readiness which initiates and regulates various forms of conduct, just as the task initiates and directs the course of a single act. It arises from an appreciation of the value of the conceived goal. The value of the goal is appreciated when the individual regards it as a source of satisfactions, or as a means of avoiding annoyances. The generality of the determining effect of an ideal will depend upon the extent to which the individual's concept is generalized, and the reach of his understanding of the kinds of behavior by which his purpose may be realized.

By way of illustration consider the ideal of *honesty*. Here the individual has an understanding of what it means to be honest; he feels that honesty is worth while, and purposes to be honest in all matters that come within the range of his ideal. His goal is to be an honest individual. His concept of honesty may be very imperfect, in which case he is likely to be honest in some situations and not in others. Likewise, the ideal of *punctuality* will involve first an understanding of what it means to be punctual. But even though the individual has a well generalized concept of punctuality, his ideal will not be fully generalized and he will not be consistently punctual if he feels the need for being punctual in only some of his appointments.

ENGENDERING IDEALS

The engendering of an ideal involves both the development of an adequate concept or understanding and the establishment of a motive or a goal of conduct in accord with the concept. The ideal will be complete and effective only to the extent to which we succeed in establishing both of these essential ingredients.

Understanding. The conceptual aspect of the ideal may be taught directly as we would teach any concept. This is essential but not sufficient. To develop the ideal of honesty, for example, the child must be taught what honesty means. We may start with specific examples of honest conduct. We may "vary the concomitants" by means of illustrations of honesty in varied situations and in different sorts of behavior. By this procedure and by examples of dishonest conduct (contrast) we may isolate and abstract the feature of concrete acts which makes them honest. If this element is clearly grasped, it will serve as a basis for judging the honesty of various concrete forms of conduct. One of the difficulties encountered here is that adults who attempt to teach children are not always clear in their own minds about what constitutes honesty. A college student who was conscientious and who had a sincere desire to be honest once came to the writer for counsel. The day before, his help had been solicited by a fellow student during an examination. He knew that it was not right to cheat on an examination, but he wanted to know whether the faculty considered it as serious an offense to give help to another during an examination as to secure it.

To establish an ideal of neatness, children need to be taught what neatness means and all the various ways of being neat. They need to be taught what it means to be punctual, loyal, just, amiable, industrious, and so on for all the ideals which we seek to inculcate. But knowledge is not enough to insure the desired conduct, and this is probably why the direct instruction for character education has so miserably failed in most cases. An explanation of what is right plus an admonition always to do what is right will do little good if the motive which impels and directs behavior is not established.

Establishment of goal. The critical phase in the process of establishing an ideal is the actual adoption of the conceived standard of conduct or level of achievement as a goal. To secure this the child must truly appreciate its value. Direct instruction alone is likely to be unsuccessful in putting the necessary motive behind the pupil's knowledge to insure its application in practice. Knowledge of right does not insure right conduct. An appeal to personal concern is usually more effective than mottoes, slogans, and admonitions; and example is more convincing than logical argument.

The effectiveness of example depends, however, upon several things. 1. It should be consistent. Occasional lapses from the ideal in the conduct of the teacher or parent will undermine the effect of many good examples. 2. The prestige of the person who sets the example is an important factor. The conduct of an admired fellow student, a highly respected teacher, a beloved parent, or public official is likely to carry more weight than that of unknown, unimportant, or disliked persons. 3. To influence a child in the desired direction, the example of good conduct should be accompanied by evidence of satisfaction derived from such conduct. If one's conformity to ideal standards appears to be annoying, it will not favorably impress the child. If the pupil sees, for example, that the teacher whom he respects derives satisfaction from carefully obeying the traffic regulations, he will be much more likely to regard that conduct as worth while than if he sees the teacher conform to the law grudgingly and under protest. 4. The effectiveness of the teacher's example is dependent to a large extent upon other influences in the child's life. If the examples and moral tone of the home and community are not in keeping with the standards of conduct which the teacher is attempting to establish, his efforts will be seriously handicapped.

Habits and ideals. Habit training as a means of securing desirable conduct is good as far as it goes. But the trouble with habit training is that it is not likely to carry over to other types of situation and behavior, and it is impossible to build specific habits to take care of the manifold situations which one is certain to encounter. Some years ago an attempt was made to discover by experiment the extent to which habit training transferred to other situations. Children were trained for neatness in their arithmetic papers, but this produced no improvement in the neatness of papers in other classes. Bagley suggested that if neatness could be made an ideal instead of a habit, the desired generalization would be secured (2). Ruediger put Bagley's idea to an experimental test and found that it worked. Neatness was stressed in one subject. Neat papers were required, and in addition the teachers were directed to talk with the class about the importance of neatness in other situations, such as in dress, in the home, in business, and in hospitals. The subject of neatness was not mentioned in other classes. The greatest improvement was reported for the papers from the class in which the training was given but there was definite improvement also in the other subjects. Ruediger concluded that by making the children aware of the need for neatness in the form of an ideal, the training in one subject was transferred to other subjects (39).

Where the ability to generalize is restricted, as in young children and the feeble-minded, it will be necessary to depend largely on habit training in our efforts to secure moral conduct. But as the ability to comprehend develops, we should endeavor to go beyond the building of habits to the establishment of ideals of conduct which will direct judgments and choices along socially acceptable lines.

Character training: Jones' experiment. An excellent experimental study of the relative effectiveness of three different methods of instruction for character and citizenship was made by Jones. The study was made in the public schools of Hartford, Connecticut. It included a total of 304 children in eight different classes, of which four were seventh grade, and four were eighth grade. Two of the classes, one from each grade, were used as control groups. They received no instruction in citizenship and character during the period of the experiment, which covered one whole school year.

Three different methods were used with the other three groups of each grade. Group E was given, by means of planned activity units, firsthand experience with certain problems of conduct encountered in their own lives. The units were centered around such actual events and interests as Halloween, Thanksgiving, Christmas, police, and use of the library. There were thirteen such units in all. The Halloween unit, for example, planned for furthering respect for property and the rights of others, included planning for a parade, designing of costumes, arranging parties, and other enterprises to occupy the pupil's evening in wholesome enjoyment. In this group no attempt was made to generalize the learning. Group D was entirely a discussion group. It considered the same problems, but the instruction was wholly verbal. The third group, E–D, was taught by means of a combination of the methods used in the other two groups.

Tests of honesty and coöperation were given before and after the period of training. The results indicated that the combination of experiencing and discussion proved to be the best method for securing improvement. It resulted in measurable gains in moral behavior, though these gains were not large. The discussion method alone and the activity method alone appeared to be quite unsuccessful. From the experiencing method there appeared to be little gain other than in the specific habits practiced. Transfer effects had not been sought, and there apparently were none. The discussion method was better than the others for transfer to test situations comparatively remote from the teaching situations, but as a means for securing improvement in behavior in a specific situation it was definitely inferior to experience and training in that particular situation.

The study in general indicated that some improvement can be made in character and social behavior by means of planned instruction, and that for such improvement we need meaningful experiences in specific situations plus discussion and instruction aimed at generalization to secure transfer of the experience to other situations (25).

Summary of the Chapter

The development of attitudes and ideals is important for the welfare of the individual and of society. An attitude is a form of set or readiness for certain types of response. Its scope of control is broader than that of habit. Three fundamental attitudes are: appreciation, knowledge, and use. They and other attitudes control a wide variety of responses.

The case histories of delinquents and criminals generally reveal faulty social attitudes. The reformation of such individuals requires the correction of their attitudes. In order to maintain our democratic institutions the school must instill in the youth of the nation democratic ideals and attitudes.

Many studies have been made of the attitudes of children and students. They have shown the prevalence of a considerable degree of racial prejudice, a difference in subject preference for pupils of high- and low-grade intelligence, reading tastes not in accord with what is studied in the English classes, and age differences in reading interests.

College students do not tend to be atheistic but generally hold to the fundamental religious teachings. Before the outbreak of the war students leaned toward pacifism and were quite generally opposed to war.

Attitudes are acquired by imitation, from emotional experiences and conditioning, from various kinds of informative experiences, and by deliberate cultivation. We have experimental evidence to the effect that attitudes are modified by instruction given in the classroom. Jones found that during the four years in college the students tended to become slightly more liberal toward certain social and religious issues. Failure is the source of many unwholesome attitudes, the removal of which requires encouragement and provision for success. Physical handicaps also may give rise to troublesome attitudes. These should be remedied if possible, and if they are not remediable, the child should be taught to adjust to his misfortune. The school should seek to develop an appreciation of nature, art, music, and good literature for the purpose of providing sources of enjoyment. To this end the child should be taught to see the beauty in them.

A number of attitude tests have been devised in recent years. These are so arranged that the degree of favorableness or unfavorableness toward the topic of the test can be indicated by a score.

An ideal is a form of set or readiness in which a goal is broadly conceived. In engendering ideals it is essential to develop an understanding of what the ideal implies in the way of behavior and also to secure the adoption of the conceived standard of conduct as a goal. The conceptual aspect of the ideal can be taught by direct instruction but the acceptance of it as a goal requires an appreciation of its value which is more likely to be secured through example.

For character education we need more than habit training. Jones' extensive study of methods of instruction in character education indicated that activity training plus discussion aimed at generalization was successful in securing measurable gains in moral behavior, while discussion alone and the activity training without discussion did not produce appreciable gains.

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PART V

RETENTION AND TRANSFER OF LEARNING

CHAPTER XVIII

RETENTION, RECALL, AND RECOGNITION

Memorial apprehension. Remembering, as a psychological function, is a particular way of apprehending an object or event (page 293). In this form of function we think of some object previously encountered or something that took place in the past. But this past is our own, and in our remembering we definitely regard the object of our thought as something belonging to our own past experience. The distinguishing mark of the memorial function is this retrospective reference and the localization of the apprehended object or event within our own personal history. We have memory in this form when we remember the things we did last summer, the time we were late for class, the talk we gave at one of the meetings of our club, or the death of a friend. Usually our clearest recollections are for events and objects we have experienced only once. Memory of this sort is *memorial apprehension* (cf. 6).

Associative memory. The term *memory,* however, is commonly used to refer not only to the memorial functions but also to the persistence and use of the products of memorizing and informational learning (cf. 116). In this sense one often speaks of his memory of a poem learned by rote or of facts made fast by repetition. But the poem may be recited without any retrospective reference and the giving of answers to fact questions may contain no regard to the past scene. Repetition enables us to recite the poem verbatim, but it tends to eliminate from the process of reproduction the meaningful reference to the past. This form of memory is a matter of association, and to distinguish it from the apprehending memorial function we call it *associative memory.*

Traditionally the subject of associative memory has been divided into four main divisions, namely: first, impression; second, retention; third, recall; and fourth, recognition. The first of these pertains to the establishment of the associative (functional) tendencies. This being a matter of learning has been covered in previous chapters, particularly those dealing with memorizing and comprehension. The old term "impression," however, is hardly adequate for denoting the active role of the learner. It implies a rather passive reception by the learner of impressions made by his environment. This, as we have endeavored to point out throughout this volume, is not the way one learns. Learning results from what one does. It is not something impressed upon him by his environment. As a matter of the persistence of the outcomes of learning and their functional efficacy we have in this chapter to consider the topics of *retention, recall,* and *recognition.*

RETENTION

What is retained? The notion that ideas as mental entities or existences are retained in the memory or anywhere else seems fantastic in the light of modern studies. An idea is a meaningful experience. It is an event, and, as an event, once it has taken place it can never return. We may repeatedly think of the same thing, but each instance of thinking of it is a new event. What reappears in identical or similar form is not the event but the meaning or object of thought. We may today think of an object which yesterday we experienced in perception. But in the meantime we have not been carrying around the idea of it as a block of mental substance in the mysterious recesses of a subconscious mind. What then do we carry with us during the interval between learning and recall? The most satisfactory explanation to date is that through the interval we carry the means of recall in the form of functional tendencies. The perception of the object or event we recall, or the learning of what is reproduced, leaves a trace in the form of a functional trend in the nervous system, and this trace in neural structure makes recall or reproduction possible. This is the neurological theory of retention. Behind it are the established facts that all psychological functions are dependent upon neural functions, and a destruction of certain portions of the brain eliminates the possibility of recall.

Forgetting. The most significant fact of the period following learning is the decline in the ability to reproduce what has been learned. The associative tendencies if not used tend to weaken and disappear.

Whether the loss by forgetting is to be regarded as unfortunate or not depends upon the nature and value of the acquisition. Some things we learn are of no value and hence their loss is not to be regretted. Then there are the results of learning which serve a temporary purpose, and these may as well be forgotten after they have no further service to render. We know that much of the factual content of courses of study in our schools is soon lost if it is not reviewed or used. But this does not mean that the learning of it has been a waste of time. Not only may this material have served to develop comprehension of general principles which are retained, but if needed, it can be relearned in less time than at first, and the student probably will know where and how to find the information when he needs it. Where learning outcomes have permanent values, we should seek permanent retention. Here the factors which contribute to the rate of forgetting and the conditions favorable to retention and recall will be of real significance for the teacher.

Experimental Methods for Measuring Retention

Several different methods have been devised and used for measuring the amount of retention in the quantitative studies on associative memory. These methods are the procedures followed for scoring the amount of learning retained for various periods of time after the discontinuance of practice. A brief description of the principal forms of measurement is given here, since we shall have occasion to refer to some of them frequently throughout the present chapter. Included in the list are methods that call for reproduction immediately after the presentation of the learning material, for while these may be thought of as measures of learning, there is, in such cases, at least retention of the impression for a few seconds. Furthermore, there is not a sharp division between methods for measuring learning and those for measuring retention, since in all cases of continued practice there is a mingling of learning and retention. Without retention during learning there could not be the accumulative acquisition of functional change that takes place during the periods of continued practice.

Memory-span method. This method was one of the first to be used in quantitative studies of memory. A person's memory span is the largest number of items he can correctly reproduce immediately after one presentation. The items used may be digits, letters, syllables, words, geometrical figures, or any other kind of material that readily falls into a series of approximately equal units. There is no single fixed memory span but rather a memory span for each particular set of conditions under which the presentation is made. For example, if we say a person's memory span is seven, we mean that it is seven for a certain kind of material, presented under specified conditions, and scored according to a particular procedure. An individual's memory span for digits may differ from his memory span for words or other types of items. His memory span for digits read by the experimenter may differ from his span for digits presented visually by means of cards.

The typical procedure in memory-span experiments is to present several series varying in length from three or four items, which the subject may be expected to get every time, up to twelve or thirteen, which is clearly beyond his ability to reproduce. Between these limits is located the number that is correctly reproduced in just fifty per cent of the trials. This number is taken as the measure of the memory span. By keeping all the conditions of the experiment constant save one, which is varied at will, the experimenter can determine the influence of that factor on the memory span for those conditions. By using in turn other factors as variables, he can explore the complex of conditions which affect this relatively simple act of memory.

Various studies on the memory span indicate that it varies not only with the rate and sense modality of the presentation, the scoring method, and materials used (8), but also with the rhythm of presentation, time of day, practice, distraction, attitude, fatigue, the subject's grouping of the items presented, and other influences (7). It has been found to increase with age up to the point of mental maturity, and this finding has been put to practical use in the digit tests of the Binet scales for measuring intelligence (97). With the auditory method of presentation the memory span of college students for digits usually falls between six and eight. Ebbinghaus could recite seven nonsense syllables after one reading. The span for meaningful words is greater than for nonsense syllables, and still greater for words related into a meaningful sentence. Accounts of the various ways of calculating the number of items correctly reproduced in memory-span experiments are published elsewhere and need not be given here (43, 115*a*).

The method of retained members. When this method is used, the length of the material exceeds the memory span and the number of trials or presentations is insufficient for complete learning. Retention is scored in terms of the number of items the subject can reproduce either immediately after learning or at a later time. It is a *recall* test and as such may not yield an accurate measure of retention, because an individual is sometimes unable to recall what he has retained. This method is a convenient one to use with groups. We can present a series, say, of twenty-five terms printed on cards. If it would take about six presentations for the average member of the group to master the list completely, we might present it three times. We then ask the subjects to write down all they can remember from the list. Scoring in terms of the number of items recalled, we may, by analyzing our data, explore differences in learning with respect to sex, age, intelligence, and so on. By keeping other conditions constant we may, by presenting lists of different kinds of materials, study the relative learning difficulty of these materials. So also we could compare the effectiveness of different methods of presentation.

The method of recall. This method is similar to the method of retained members except that it is used where learning is carried to the point of an adopted criterion of learning, such as one or two perfect recitals. Scoring is in terms of the number of items reproduced. In the carefully controlled experiments in which this method is used to measure retention care is usually taken to control the degree of learning. Overlearning is usually avoided or made constant unless discovering the effects of overlearning on retention is the aim of the experiment. In that case an effort is made to secure varying amounts of overlearning while the other factors are held constant.

School testing relies heavily on the recall method of measuring retention. The usual classroom, however, lacks the precise controls of the conditions and degrees of learning found in good laboratory experiments. Too often children are rated exclusively on the amount of the lesson they can reproduce or the number of memorized facts they can recall and write down on an examination paper. We should remember that not only may a child know more than he can recall at a given time, but that there are other devices for gauging the persistence of learning outcomes, which in some cases are more appropriate than recall. Some of these other means are used in objective tests. In the evaluation of school progress, moreover, we need to consider the cumulative growth of the child, changes in attitudes, and the development of the ability to solve problems by thinking. Such outcomes are not only more important in the light of educational objectives, but they appear to be more permanent acquisitions than the facts we ask pupils to reproduce in examinations.

The recognition method. The ability to recognize an object depends upon previous experience with it. It is as much an outcome of learning as is recall. Therefore, we are measuring the persistence of the results of learning when we ascertain the extent of one's ability to recognize items previously experienced. The characteristic features of the recognition method of measuring retention are: first, the presentation one or more times of a list of items for learning; second, a test given immediately after this presentation or later, in which the same items are again presented but mixed with a number of other items of the same class; and third, the report by the subject on each item of the test series regarding whether that item appeared in the list originally presented. Scoring is in terms of the number of items correctly recognized. For example, if we let letters represent the items used, we might present for learning M Z D G X B J Y and for the test series K U G Z O N D T J M P X Q Y B F. The subject would be asked to state for each item in the second group whether or not it appeared in the first one.

It is customary, though not essential, to have an equal number of original and new items in the test series. Two kinds of errors may be made in the test, false recognition of the new items and failure to recognize members of the original list. Since the subject has an even chance for making a correct response for each item if he merely guesses, in computing his score the number of wrong responses is subtracted from the number right.

A variation of this method, which reduces the chance of getting correct responses by guessing, is the *multiple choice* test. In this procedure one of the items from the original list is presented with several new items. For example, if M is one of the original items, in the test might appear this group: Z D X M N. To make a correct response the subject must pick the right one out of the five. His chances for a correct response by pure guessing here would be only one in five.

Recognition testing except in certain forms of objective test questions is used very little in school. Some true-false questions, though not all of them, are really tests of recognition. For example, suppose the reading lesson included a statement that the dog was white. We would be testing recognition if we asked the reader to mark as true or false the statements, "The dog was white" (an item from the learning series), or "The dog was black" (a new item of the test series). A multiple choice question would be, "The dog was: brown, white, black, spotted, yellow"—with instructions to underline the correct answer. The essential feature of recognition testing lies in the direct appearance in the test series of the actual items presented during learning. In the recall methods the item to be reproduced is not presented in the test. Its recall is aroused by means of a stimulus or cue associated with it during learning. A recall question from our example would be, "What was the color of the dog?"

It is generally found that higher percentage scores of retention result from recognition testing than from the recall methods, and this is taken to mean that recognition is easier than recall. This is probably true, because in recognition tests the subject actually has before him the identical stimulus-pattern he previously observed. It is to be expected that this would contain more adequate reminders of the earlier impression than something else connected with it. Even if it does result in a higher percentage score of retention, its use can help us distinguish between effective learning, poor learning, and no learning at all. Its use in testing certain forms of school learning seems not only justified but desirable as well. Our testing should be in accord with the desired outcomes. The value of learning is not restricted to the ability to reproduce. In many cases the values of a study are fully realized if one is able to recognize a statement as true or false when he reads it, or if he knows what an object is when he sees it. Apparently, no one has undertaken to determine what proportion of our learning serves its purpose on the recognition level. Certainly a considerable proportion of it does.

Regarding the relative difficulty of recognition tests and recall tests it may be noted that the difficulty of the former depends largely on the extent to which the additional items of the test series are similar to those of the learning list. Greater similarity here means greater difficulty.

The method of paired associates. In this method the items are arranged in pairs and the list is presented under instructions to learn the pairs so that later when the first member of each pair is given, the second may be recalled. The first member is called the "stimulus" item and the second the "response" item. The pairs may consist of two words, a word and a number, two nonsense syllables, or items of other kinds of material. The score consists of the number of appropriate responses given when the stimulus items are presented in the test. To illustrate, we might present for learning: house—*62*, leaf—*96*, dog—*35*, fire—*43*, wood—*54*, and so forth. After the interval we would present the words one at a time, and the subject would be expected to give the number paired with each. The total number of correct responses is the score.

There are many cases of paired-associates learning and testing to be found in school practices. For example, the pupils are asked to learn the following in pairs: dates and events, states and their capitals, authors and their books, English words and their equivalents in a foreign language. The arithmetic combinations are forms of paired associates. In the tests covering this work the first term is expected to bring forth the second, and the child's mastery is judged by the number of correct responses he can make.

The anticipation and prompting method. In this method the items to be learned are presented in serial order, and after the first presentation the experimenter pauses long enough after each item is presented to allow the subject to give the next item. If the latter fails to respond correctly within a specified number of seconds the experimenter presents the next item. This procedure is continued for each item of the list and for successive trials until the subject can give all the items without prompting.

This method has several advantages. It shows the experimenter just when complete mastery of the whole list is reached, and this is important in experiments where overlearning is to be avoided. It provides a score in terms of the number of correct anticipations for each trial and therefore a record of the subject's progress. It shows the total number of trials required for complete mastery, and since it reveals the number of promptings for each item, it shows what items were easiest and what ones were most difficult to learn.

In view of these advantages and the fact that practicing recall during learning is an economical procedure, this method should be a good one to use in the classroom. It is easier to manage with one child or with a small group than with a large group. But it can be adapted to group use by having the pupils write down during each trial their anticipations, and cover what they have written, before starting on the next trial. The pupils' desire to get the "right answer" before the teacher tells it should serve as an excellent source of motivation. If an incorrect response is given, it is corrected at once with the presentation of the next term in the list. The records will show the teacher just how far each pupil has progressed, what items require further practice, and the amount of practice needed for each. It is active learning combined with diagnostic testing.

The method of complete mastery. This is a method for measuring the rate of learning. We include it with the retention methods because progress under continued practice is possible only by the retention of the increments of gain from successive trials, and because it is employed in the relearning method of measuring retention. Learning is continued until an adopted criterion of mastery has been achieved. This criterion is usually one or two perfect recitals of the lists used.

The score is the number of trials or the total time required to reach this degree of learning.

The relearning, or saving, method. Devised by Ebbinghaus, this method has one advantage over all the other methods, and that is: It can be used to measure the degree of retention when the subject has forgotten to the extent of being unable to recall or recognize. In the usual procedure the subject learns a list of items to the point of one or sometimes two perfect recitals. Since the material is not overlearned, it is soon forgotten so that its recall is impossible. After an interval the subject relearns the same list to the same criterion of mastery. Ordinarily it takes less time to relearn than was required for the original learning. The time saved, that is, the difference between the time required for learning and for relearning, is taken as the measure of retention existing at the time relearning was undertaken. It is commonly stated in terms of the percentage of the original learning time. Thus, if it takes a person ten minutes to learn a list of words to the point of one perfect recital, and four minutes to relearn it after five hours, the time saved for relearning as a result of having previously learned the list would be six minutes. This would indicate a saving or retention of sixty per cent, and a loss of forty per cent for the five-hour interval. The difference between the number of trials required for learning and for relearning may also be used as an index of the amount of retention, when this method is employed.

The reconstruction method. In testing retention by this method the experimenter first presents to the subject a group of items in a certain order or pattern. He then breaks up the arrangement and turns the materials over to the subject who tries to arrange them in the former order or pattern. The unique feature of this method is that it calls for the reproduction, not of the items, but of the order or arrangement in which they are originally presented. It may be used not only for verbal materials but also for colors, odors, and objects of various sorts. When this method is used to measure learning, the score is usually based on the number of trials or time required to learn the arrangement well enough to reproduce it exactly. When using it to secure a measure of retention over an interval following learning, the degree to which the reconstructed order coincides with the presented order may be taken as the basis for scoring.

A number of practical adaptations of this method may be made. For example, in the domestic science course the teacher may test her students' mastery of the lesson on the proper arrangement of the dishes and utensils on the dinner table by having them set the table. After the members of a class in general science have been shown an electric bell correctly connected with batteries and switch, a good reconstruction test of the knowledge gained would be to separate the parts of the assemblage and have the pupils attempt to put them together again. The soldier in training must learn to take his gun apart and put it together again. In any case where the proper assembling or arrangement of materials or parts is the aim of teaching, this method with suitable adaptations may be used to determine the extent to which the aim has been achieved.

The method of report. In studies using this method the subject witnesses an incident or is given a certain time to examine a picture or collection of objects and then is asked to give a full report of his observations. His report may be in the form of a narrative in which he tells all he can remember of the details of the event or situation without prompting, or it may be made in the form of answers to a series of specific questions. The scoring is based upon the number of items correctly reported.

This method has been used in the study of the psychology of testimony. Through its use the narrative and question-answer forms of testimony have been compared for reliability and range, the various types of errors appearing in reports have been detected, and the influence of the form of the question has been studied. An example of the use of this method in the school situation is the report pupils are asked to make on a field trip.

The Curve of Retention

The first quantitative work on retention was done by Ebbinghaus (1885). He learned, to the point of two correct recitals, several hundred lists of thirteen nonsense syllables. He recorded the time required for the original learning and then relearned these lists after a lapse of time. The relearning required less time than the original, and the difference in time required was taken as the measure of the amount of retention at the time the relearning was undertaken. The retention for various intervals from one third of an hour to thirty-one days was determined by this relearning method. It was necessary to use a different set of lists for each interval studied because the relearning of a series would restore loss up to that point and, therefore, the time saved in relearning the same series a second time would not provide a measure of retention for the original learning. The percentages retained and forgotten as indicated by the mean time saved for relearning several series after various intervals were as follows:

Interval	*Per Cent Forgotten*	*Per Cent Retained*
⅓ hour	42	58
1 hour	56	44
8¾ hours	64	36
1 day	66	34
2 days	72	28
6 days	75	25
31 days	79	21

These data indicate that the rate of forgetting is most rapid immediately following learning and tends to slow up for what remains as the interval lengthens. Even after thirty-one days had elapsed there was evidence of retention in the fact that the original learning was responsible for a saving of twenty-one per cent in the time required for relearning. We find that the curve of retention for nonsense syllables, considered from the standpoint of what is retained rather than what is lost, is negatively accelerated, showing a rapid drop during the first hours after learning and a leveling off with a slower approach to zero retention as time passes.

Although the findings of Ebbinghaus were based on results from only one subject, his work was so thoroughly and carefully done that the results of a number of studies carried out since his time have been in substantial agreement. Other methods and other types of material than those employed by Ebbinghaus show larger percentages retained, but, in general, the results indicate a relatively rapid decline in retention during the first part of the interval followed by a slower rate of forgetting. This has been found by use of the recall method for monosyllabic words (114), poetry (113), prose (10, 28), lecture material (51), and school subjects (95).

A unique study of long-term retention of meaningless material from infancy was made by Burtt (17, 18, 19). The experiment began when the subject, a boy whose I.Q. was about 130, was fifteen months old. Each day for three months three selections in Greek were read aloud once to the child. Between the eighteenth and twenty-first months three other selections were read daily. This procedure, with a different set of selections for each successive three-month period, was continued until the child was three years old, making a total of twenty-one selections presented. At the age of eight and one-half years the subject learned seven of these selections and three new ones by the anticipation method. At fourteen years he learned a second third of them together with three new selections for control; and at the age of eighteen the remaining seven and three new ones were learned. The saving in learning trials for the selections presented in infancy was approximately thirty per cent at the age of eight and one-half years, and eight per cent at the age of fourteen. At eighteen years the results were negative. The effects of presentation in infancy were clearly evident at eight and one-half years. There was considerable loss in retention during the six years from eight to fourteen, and by the age of eighteen there was no evidence of the retention of the early impressions.

Factors That Influence the Rate of Forgetting

In considering the factors which influence forgetting, it should be borne in mind that the form of the curve of retention has been found to differ for different methods of measuring retention. Luh (56), for example, obtained curves of retention for lists of nonsense syllables by means of five different methods of measurement. The curve for retention measured in terms of the ability to recognize not only showed a greater amount of retention throughout the two-day interval, but the rate of decline was less than for other methods. The retention curves for the methods of reconstruction, relearning, and recall all showed a steep drop for the first four hours, but from then on the curve for the relearning method showed comparatively little loss, while the others continued to drop as indicated by tests given at the end of one and two days.

Meaning. Meaningfulness of the material learned and the degree to which it is related to earlier learning appear to be important factors in retention. It has been found that after one presentation of fifteen nonsense syllables and a like number of monosyllabic words considerably more of the latter can be immediately reproduced, and a still larger number of related words can be reproduced under the same learning conditions (chapter XIII). This, of course, does not indicate the course of forgetting during the period that follows learning. The difficulties of dealing experimentally with this question are numerous and further evidence from carefully controlled studies is needed (64*a*). In one study the retention curve for nonsense syllables fell considerably below the curve for poems and appeared to drop faster between the second and the tenth month (115*b*). Experiments on the retention of words, poetry, and factual prose in which the recall method was used have not shown so large a percentage of loss during the first few hours after learning as was found by Ebbinghaus for nonsense syllables by the relearning method. The evidence indicates that we remember better what we understand than what we do not understand.

Overlearning. Experimental evidence that overlearning enhances retention was first presented by Ebbinghaus (1885). He found that each reading of a sixteen-syllable series effected approximately the same amount of saving in time (12.7 seconds) for relearning after an interval of twenty-four hours. This applied not only when the number of readings were insufficient for correct recital of the series read, but also when he continued to repeat the series beyond the point where it was completely learned. About thirty-two repetitions were sufficient for perfect recital. That number of readings effected a saving of 407 seconds for the subsequent relearning. But when the series was repeated sixty-four times a saving of 816 seconds was realized.

That overlearning improves retention for rote learning of meaningful words was demonstrated experimentally by Krueger (52). The learning material consisted of lists of twelve one-syllable nouns. The anticipation method of learning was used. Each list was considered learned to 100 per cent when the subject could anticipate correctly all of the words during a single presentation. Two degrees of overlearning were employed. In one (fifty per cent overlearning) the lists were shown one and one-half times the number of presentations required for 100 per cent learning. In the other (100 per cent overlearning) the number of presentations was twice that required for 100 per cent learning. Tests for retention were given after intervals of one, two, four, seven, fourteen, and twenty-eight days. Both the recall method and the relearning method were used for measuring retention. The scores indicated that for the one-day interval retention for fifty per cent overlearning was about fifty per cent better than for 100 per cent learning, and that the longer the interval the greater was the superiority of retention from the overlearning. The 100 per cent overlearning brought higher test scores after each interval with both recall and relearning than were obtained from fifty per cent overlearning, but the superiority of 100 per cent overlearning over fifty per cent overlearning was less than the superiority of fifty per cent overlearning over 100 per cent learning. Thus, there appeared to be a diminishing advantage as the degree of overlearning was increased. This study indicates that overlearning, at least to the extent of fifty per cent, increases retention, and that the longer the interval the greater is its value. These findings are significant for memory drills and for all other cases where retention for a long period is desired. It should be noted, however, that to be effective the repetitions beyond the threshold of recall require the same high degree of attention as those which precede the first perfect recital.

Distribution of practice. For retention over a long period of time distributed practice is more effective than having the learning and overlearning all done at one time. This is indicated by one of the experiments of Ebbinghaus (1885), in which he relearned on each day for five successive days lists of syllables and lines from Byron's "Don Juan." Each successive relearning was accomplished in less time. Although the criterion in each case was one perfect reproduction, the degree of learning was shown, by the increased amount of retention, to be greater for each successive relearning. This recalls the statement by Jost (chapter XIII) that old associations are strengthened by repetition more than new ones, and signifies the importance of a number of well-spaced reviews.

Several studies support this view that distributed effort in learning yields better retention than the same amount of effort expended in massed learning. Hovland (48), for example, found that when college students learned lists of nonsense syllables to the criterion of one perfect recitation by massed practice (six seconds between trials) and by distributed practice (two minutes between trials), retention, tested after intervals of six seconds, two minutes, ten minutes, and twenty-four hours, was better for the lists learned by distributed practice. Likewise, Cain and Willey (23) found that recall scores were substantially higher after one day for nonsense syllables learned by distributed practice than for those learned by massed practice, and the difference was greater after intervals of three and seven days. Relearning scores were also better for the groups whose practice was spaced.

Since the curve of retention usually drops most rapidly during the first part of the interval following learning, it seems reasonable to suppose that for best retention relearning or reviews should come at comparatively short intervals after learning and then farther and farther apart as time passes. This view is supported not only in common experience and practice but also in the results of experimental studies. One investigator, for example, compared retention of materials learned by the paired-associates method after learning periods had been distributed first, by increasing intervals; second, by decreasing intervals; and third, by constant intervals. Tests of retention were made after three and seventeen days. The highest scores were obtained from the learning with increasing intervals. The decreasing intervals took second place, and the constant intervals yielded the poorest scores of the three forms of distribution employed (101).

The influence of set. Retention following learning carried on with the intent to remember, is superior to that which follows passive observation, and the difference appears to be greater after twenty-four hours than immediately after learning (80). Experiments have also shown better retention when a person learns with the purpose of retaining for a definite period of time (98), and there is evidence to the effect that a student will recall better on a test that comes at the time for which he studied than on one that comes before or after he expected it (38).

Retention, furthermore, is definitely affected by the learner's prejudices, likes, and dislikes with respect to the content of the learning material. If he likes and agrees with the ideas he reads, he tends to remember them better than if he does not (30). If he is a pacifist and reads an article on war that contains both favorable and unfavorable comments on the subject, he will tend to remember the unfavorable ones better because of his own set. The influence of the attitude toward Negroes on the recognition of pictures of Negroes was demonstrated by Seeleman (87). An equal number of pictures of Negroes and whites was presented to two groups, one favorable, the other unfavorable to the Negro. After ten minutes a recognition test was given. The group with the pro-Negro attitude recognized more of the pictures of the Negroes than did the other group.

The amount learned and retention. Are longer lists or longer lessons remembered better than short lists or short lessons? The answer seems to be "Yes," provided the longer material is learned to the same degree. Ebbinghaus learned lists of nonsense syllables of different lengths and computed the saving when the same lists were relearned after twenty-four hours. The twelve-syllable list was relearned with a saving of thirty-five per cent, the twenty-four-syllable list with a saving of forty-nine per cent, and the thirty-six-syllable list with a saving of fifty-eight per cent. The greater savings for the longer lists indicate that a relatively larger amount was retained. This may be owing in part to the fact that the longer lists required more readings. The twelve syllables required seventeen readings, the twenty-four syllables required forty-five readings, and the thirty-six-syllable list required fifty-six readings. Thus, each syllable in the longer lists was seen many more times.

These results have been verified in principle by other investigators who have used other materials and other methods. Robinson and Heron (85) experimented with lists of nonsense syllables, and Robinson and Darrow (84) with three-place numbers. Their results indicated the tendency toward a greater percentage of retention for the longer lists with both the recall and relearning methods. When controls have been used to prevent overlearning of various units of the longer lists by eliminating them from the series as soon as they are learned, the recall and relearning scores have been found to be approximately the same for lists of differing lengths. This was the finding in an experiment on paired-associates learning where each pair was removed as soon as the subject had responded correctly with its second member three times (86).

That the larger number of presentations in the case of the longer lists is not the full explanation of the higher retention rates found for longer materials is indicated by a study made by Woodworth (115*c*). To a group of twenty-five students he read lists of words arranged in pairs at the rate of one pair every six seconds. The subjects were instructed to learn each pair so that when the first one of the pair was presented they could recall the second. The lists varied in length, containing five, ten, twenty, and thirty word pairs respectively. The prompting method was used, and each list was read three times. A recall test of retention was given two days later. For immediate recall the percentages were higher for the shorter lists, but after two days the percentages of the various lists recalled were as follows: five-pair list, four per cent; ten-pair list, sixteen per cent; twenty-pair list, thirty-six per cent; thirty-pair list, thirty-four per cent. Thus, retention was higher for the longer lists even though they were presented the same number of times as the shorter ones, and the same time was allotted to each word-pair in all of the lists. The fact, however, that the thirty-word list fell short of the twenty-word list suggests that there is probably a limit beyond which the returns begin to decrease. Woodworth suggests that in the harder tasks the subjects were stimulated to a greater degree to find meaningful relations between the paired words.

Rate of learning. Does the fast learner forget faster or slower than the slow learner? To find the answer to this question the degree of learning and amount learned must be controlled. If a given amount of time is allowed for learning, obviously the fast learner will have acquired more and will have more to retain. A comparison therefore of the amount retained after a period of time would not be a true measure of the difference in rate of forgetting. If relearning is used to measure retention the problem is complicated by the fact that the fast learner will relearn faster than the slow learner. In this case the retention scores of the faster learner would be spuriously higher than the slow learner's. If the fast learner and the slow learner are both required to reach the same criterion of mastery the slow learner may in the greater amount of time employed overlearn certain parts of the material to a greater extent than the fast learner. This would naturally give the slow learner an advantage in retention.

Where suitable controls of the degree of learning and the amount learned have been maintained the evidence indicates that the faster learner retains better than the slow learner. For example, Gillette (41) used paired-associates learning in which pictures were paired with numbers, and controlled the degree of learning of the various units by removing pairs from the list as soon as they were learned. Retention was measured by determining the number of right associates that could be given after a period of time and also by relearning. Under both methods of measurement the fast learners showed superior retention.

We should expect retention to be related positively to learning rate because the rate of learning is actually a matter of the amount retained from trial to trial during the learning period, and retention is measured by the amount retained after a period of no practice. The only real difference lies in the length of the period through which the results of learning are retained.

Affectively toned material. For a number of years studies have been centered on the influence of affectivity on retention. As stated in the chapter on memorization, the memory value has usually been found to be greater for pleasant than for unpleasant materials, and also greater for unpleasant than for affectively indifferent materials.

The investigation of this problem has been difficult because of the many complicating factors involved. One of these is the factor of vividness. It is known that the vividness of an impression enhances its retention (104). Affective experiences are usually more vividly impressed than indifferent ones, and this would tend to increase their frequency of recall. Another fact to be taken into account is the greater frequency for most persons of pleasant experiences than unpleasant ones (34). The very fact that one has more pleasant experiences would account to some extent for the greater number of pleasant than unpleasant experiences recalled. Then the degree of affectivity varies for both pleasant and unpleasant experiences, a fact which makes reliable measurement difficult. Also the affective toning of an experience tends to change with the lapse of time and under repetition.

Because of these features of the problem the method of free recall of experiences often used in earlier studies is not considered dependable. In this method individuals were asked to list all the experiences of a given period which they could recall and then rate them as pleasant, unpleasant, or indifferent. In most cases this method has shown more affective than indifferent memories and more pleasant than unpleasant ones. But the results are obviously determined not by the factor of affectivity alone.

A more satisfactory method of dealing with this problem is one in which the subjects learn a list of terms judged to be pleasant, unpleasant, or indifferent, and then after an interval they are tested to determine the differences in retention for the three kinds of items. This method, however, is limited by the following facts: Words in an experimental list may not have the same affective values as in other situations; a word may have a pleasant or unpleasant meaning without actually arousing the feeling (119); and the words in such a list may differ in degree of familiarity or number of associations. In the light of these complicating influences it is not surprising to find some disagreement among investigators. The gist of the evidence, however, seems to justify the following tentative conclusions: First, pleasant material is usually retained better than unpleasant material: second, the greater retention value of pleasant material tends to increase as time passes, but eventually it decreases as complete forgetting of both kinds of material is approached; third, for children this difference between the retention of pleasant and unpleasant material is much less than for adults; fourth, unpleasant material is usually retained better than indifferent material; fifth, both pleasant and unpleasant experiences tend to lose their affective toning and to approach indifference as time passes, but this tendency is greater in the case of unpleasant experiences; sixth, the factor of vividness plays a part in the recall of affective material, but compared with feeling its influence is greater for immediate recall than for delayed recall (4, 24, 29, 40, 75).

Forgetting during sleep. In one of his studies of retention Ebbinghaus found that the amount forgotten between the twenty-fourth and forty-eighth hours after learning was about three times as great as that lost during a fifteen-hour period falling between 8.8 and twenty-four hours after learning. This was not in line with the usual findings that indicated a slower forgetting rate for the intervals farther removed from learning. It was observed that the proportion of time spent in sleep was greater for the earlier fifteen-hour period than for the later twenty-four-hour period, and it was suggested that sleep might favor retention. This explanation was not accepted by Ebbinghaus, who considered forgetting a function of time. He attributed these exceptional results to experimental error. But later on experiments were undertaken by other investigators to discover the relation of sleep to retention.

Jenkins and Dallenbach (49) made the first real test of the hypothesis, rejected by Ebbinghaus, that forgetting takes place at a slower rate during sleep than during waking periods. Two college seniors served as subjects. They learned lists of ten nonsense syllables to the point of one correct reproduction, some in the morning and some at night just before going to sleep. Tests for recall were given after intervals of from one to eight hours. The results indicated a striking difference between the amount forgotten during periods of sleep and of waking. More than twice as many syllables were correctly recalled after intervals of sleep than after the intervals in which the subjects were awake. Considerably more were reproduced after one and two hours of sleep than for the corresponding intervals of waking. The amount retained continued to drop during the day, but for the periods of sleep there appeared to be no further loss after the second hour. These results led to the conclusion that forgetting is the result of the interfering or obliterating effects of experiences, impressions, and activities which follow learning. This conclusion was in opposition to the view, prevalent at the time, that forgetting is a matter of deterioration of the effects of learning with the passing of time because of disuse.

Later Van Ormer (105) investigated retention during sleep and waking by means of the relearning method with the experimental refinement of making corrections for differences in learning efficiency at different periods of the day. It was found that more readings were required to memorize lists of nonsense syllables at night than in the morning. His results were in substantial agreement with the findings of Jenkins and Dallenbach. For the first hour the rate of forgetting appeared to be about the same, as determined by relearning, for the waking and sleeping intervals, but after that retention was definitely better during the periods of sleep.

Since the results from nonsense materials do not always apply to meaningful materials, a more recent study by Newman (78) is particularly significant for educational practices. His subjects were eleven college students, and he used for learning materials three short stories equated for number of points essential and nonessential to the plot. The stories were read at different times of day and reproduced after intervals of approximately eight hours. It was found that the essential points were reproduced much better than the nonessential ones, and that there was practically no difference between the number of essential points reproduced after eight hours of sleep and after an equivalent day interval. But for the nonessential points there was a difference, and the results were in accord with the findings of the previous studies in which nonsense materials had been employed. After the eight-hour interval of sleep the subjects reproduced on the average forty-seven per cent of the nonessential points, while after the two waking periods only twenty-five per cent and nineteen per cent were recalled. Newman concluded that forgetting is due to interference produced by the events of the interval, but that the meaningful organization of the learned materials tends to counteract this action.

Woodworth (115*d*) has pointed out that sleep, to be most favorable to retention, must come immediately after learning. He refers to a study in which the subjects learned lists of nonsense syllables two or three hours before retiring and also just before retiring. The amounts of sleep intervening between learning and relearning the next day were the same, but retention was better for the materials learned just before retiring. A reasonable explanation seems to be that sleep provides an escape from many of the activities that during the waking periods tend to obliterate the impressions made by learning. Woodworth suggests that sleep following learning may favor a consolidation of these impressions, whereas activities that follow learning in the waking state may interfere with such a process of consolidation.

RETROACTIVE INHIBITION

The fact that activities of the interval following learning may and often do impair retention has been demonstrated by many experiments. This interference with retention by activities in which a person engages between learning and the test of retention is known as *retroactive inhibition*. In controlled experiments the activity of the interval is usually some other learning, and it is called the *interpolated* activity.

The usual procedure in the study of retroactive inhibition involves a control series in which the learning is followed by a period of rest. At the end of this period retention is tested, usually by recall or relearning. The *rest* is usually some form of relaxation with perhaps light reading, an interesting game, or physical exercise designed to occupy the subject sufficiently to prevent his reviewing what he has learned. In the experimental series a second learning task is inserted at some point in the interval before retention of the original learning is tested. Since the other conditions are alike for the two series, the differences in retention may be ascribed to the presence of the interpolated activity in the one case and its absence in the other.

This procedure and the meaning of retroactive inhibition may be illustrated by a simple laboratory demonstration. The subjects were seven students. The learning materials consisted of eight lists of ten words. Four of these lists were used for the experimental series, and four for the control. The counterbalanced order (E C E C C E C E) was followed to equalize practice and fatigue effects. Each word list was read to the subjects once. Then after thirty seconds each student wrote down all the words he could recall from the list. In the experimental series the subjects were given heavy reading and told to study it carefully during the interval between the presentation of the list and the attempt to reproduce it. In the control series the subjects spent the interval idly looking at pictures. The recall scores were much better in the control series (pictures) than in the experimental series (hard study). From the four lists followed by study the seven subjects reproduced a total of seventy-six words, whereas from the lists followed by looking at pictures they reproduced a total of 132 words. The mean recall score for the experimental lists was 10.8 words, while for the control lists it was 18.8 words. The difference between these scores indicates the inhibiting effect of the hard study on the subjects' retention of the words. This detrimental influence of the interpolated activity on the recall scores is an example of what is meant by retroactive inhibition.

The first systematic study of retroactive inhibition was published by Müller and Pilzecker in Germany in 1900 (11). They presented to their subjects lists of pairs of nonsense syllables. The interval between the presentation and the test of retention was occupied either by studying a second series of syllables or by rest. They found that the retention was better when the subjects rested after learning and concluded that the poorer retention of the lists followed by learning a second list was due to retroactive inhibition produced by the specific activity of the interval.

Since this early study experiments have shown that retroactive inhibition may be deleterious to the retention not only of nonsense syllables but also of prose, poetry, words, and motor skills. Persistent efforts have been made to discover the conditions governing this phenomenon, for the conviction that retroactive inhibition is the main cause of normal forgetting has become general. To know the conditions of retroactive inhibition is to understand better why we forget. In the following paragraphs we shall consider some of these conditions and the experimental findings regarding them.

Similarity. *Materials and operation.* It early became apparent that the amount of retroactive inhibition is related to the degree of similarity between the original learning and the interpolated task. In an experiment published by Robinson in 1920 (82), the original learning consisted of memorizing lists of eight four-place numbers. The subjects were tested after an interval of from three to five minutes, during which they memorized more four-place numbers, series of consonants, or poetry, read a story, or multiplied four-place numbers by four-place numbers. The lowest retention scores were obtained after the interval occupied by memorizing other four-place numbers. When the original learning consisted of studying the arrangement of six chessmen on a chessboard and the interval was occupied by studying another arrangement of chessmen, by multiplication, or by reading, the greatest amount of retroactive inhibition came from studying the second arrangement of chessmen.

In another experiment which soon followed, Skaggs (92) used interpolated activities having different degrees of similarity to the original learning and found that as the similarity increased, the retroactive effect increased. But in some other experiments he found less retroactive inhibition with a high degree of similarity. From his results he concluded that retroactive inhibition tends to increase with increases in similarity up to a certain point and that beyond that point further increases in similarity approaching identity bring a reduction in the amount of inhibition.

Robinson reached a similar conclusion. He believed that if we begin with an interpolated task identical with the original and make it dissimilar by increasing degrees, there will at first be an increase in retroactive inhibition until a maximum is reached, and beyond this point further increases in dissimilarity will result in decreases in retroactive inhibition. He tested this hypothesis by an experiment (83) in which he used lists of eight consonants for learning material. He regarded the learning of the first four consonants of each list as the original task and the learning of the last four as the interpolated task. The degree of similarity of the two tasks was varied by including in the second half of each list zero, one, two, three, or four consonants that were presented in the first half. Thus, the degree of similarity here was a matter of the number of common elements in the learning material of the two tasks. The results showed an increase in retroactive inhibition with the reduction of similarity or number of common elements. Owing probably to the limitations of his learning materials there was no indication of a reversal of the trend.

Other experimenters with different methods and materials and with other ways of securing different degrees of similarity have tried to test this hypothesis. Results have varied. It appears that the Skaggs-Robinson hypothesis does not hold for all relations of similarity and that under some experimental conditions a decrease in similarity (percentages of identity) produces a corresponding increase in retroactive inhibition, while under other conditions the amount of retroactive inhibition increases with an increase in similarity (11).

Harden (44), for example, in an experiment somewhat similar to

Robinson's, used a list of four consonants (original learning) followed by four other consonants for the condition of maximum similarity. Here the last four consonants were different but as units they were of the same class. Decreasing similarity was arranged by replacing one to four consonants in the second half of the list by digits. With four consonants in the first half and four digits in the second half of the list the maximum degree of dissimilarity was attained. The results showed better recall of the first half of the list when the second half was all digits. This indicated that greater dissimilarity produced less retroactive inhibition.

Gibson and Gibson (39) had twenty-six subjects study a list of ten pairs of consonants for two minutes. After a three-minute interval spent on an interpolated task, the subjects were tested for recall of the original material. Five groups were employed, and their interpolated tasks differed in materials, in operation, or in both. The five tasks were: first, learning another list of consonants; second, learning ten pairs of digits; third, canceling paired consonants; fourth, canceling paired digits; fifth, looking at pictures. The recall scores for the groups improved in the order in which the tasks were listed. The conclusion was that similarity between the interpolated task and the original learning in either operation or material produces poorer retention than similarity in neither of these aspects of the tasks.

In an experiment by Buxton and Henry (21) a study was made of the influence of various interpolated tasks on the gains made in scores on pursuit rotor performance as a result of growth or other processes during the interval of no practice. Four groups were employed. The interpolated tasks were: first, another form of pursuit performance; second, spool packing; third, learning a simple stylus maze with mirror control; and fourth, reading. All four groups showed gains in their pursuit performances after the interval, but their gains differed. On the basis of correlations between the pursuit performances and the performances of the interpolated tasks as an index of similarity there was some indication that the amount of retroaction varied with the degree of similarity between the two tasks. The smaller gains made by some of the groups were regarded as evidence of the retroactive effect of the interpolated activity.

Meaning. That similarity of meaning as well as of operations and materials is a factor conducive to retroactive inhibition has been shown by McGeoch and McDonald (65). They used a list of adjectives for the original learning, and then compared the retroactive effects of learning synonyms of these words, antonyms, unrelated adjectives, nonsense syllables, and three-place numbers. The highest retention scores for the original lists were obtained with the numbers, the lowest with the synonyms. The scores with the other materials fell between in the order of their similarity to the original list. When the synonyms were arranged in three groups according to degree of similarity of meaning, it was found that the interpolated list with meanings most similar to the meanings of the words in the original list produced the greatest amount of retroactive inhibition. Similar results were obtained by Johnson (50), who used lists of nouns for the original learning and synonyms of three different degrees of similarity in meaning for the intervening learning. In a later study McGeoch and McGeoch (66) used lists of paired associates and found that there was more loss in retention when the interpolated material was similar to the original list in the first or in both members of the pairs than when it was unrelated or synonymous only in the second members.

Methods of learning. When the materials of the original and interpolated tasks are learned by similar methods, the amount of retroactive inhibition is likely to be greater than when different methods are employed in the two tasks. A demonstration of this fact was made in an experiment by Waters and Peel (108). Their subjects learned lists serially and by the method of paired associates. The retroactive effect of the interpolated learning was greater when paired-associates learning was followed by paired-associates learning and when serial learning was followed by serial learning than when one of the forms of learning was followed by the other form.

Degree of learning. *Original task.* Thorough learning of the original material tends to minimize the adverse effects of the interpolated activity on retention. In one of the earlier studies on this problem Heine (11) compared the retroactive effect of interpolated activity on the retention of nonsense syllables that had been repeated a different number of times. She found more inhibition for the lists repeated fewer times.

Later Pyle (81) had two groups of subjects, A and B, sort decks of 150 cards into thirty compartments numbered to correspond to the numbers on the cards. The subjects practiced for about one hour daily for thirty days. There were two arrangements of the numbering of the compartments. Group A alternated daily from one arrangement to the other. Group B practiced fifteen days on the first scheme and then spent fifteen days on the second. Group B surpassed A both in gains over initial scores and in the final speed attained. Pyle believed that practice on the second scheme inhibited the learning of the first, and that the inhibiting effect was less for B because the first arrangement was more thoroughly learned at the time practice on the second was undertaken.

The influence of the degree of learning of the original task on retroactive inhibition was clearly demonstrated by McGeoch (59). Lists of nine nonsense syllables were presented six, eleven, sixteen, or twenty-six times. For the experimental series the learning was followed by a rest of thirty seconds, and then another list of nine syllables was presented eleven times. The results indicated a tendency for retroactive inhibition to decrease as the number of repetitions of the original list was increased. The inhibition fell from 108.5 per cent at six presentations to 5.3 per cent at twenty-six presentations.

Interpolated task. Regarding the interpolated activity, it has been found that in the early stages of learning an increase in the degree to which it is learned increases its retroactive effect, but when the learning is carried to a high degree of mastery, there is sometimes a decrease in the amount of inhibition caused by it (74). McGeoch (61) obtained results indicating that after the interpolated task is completely mastered, additional repetitions do not increase its retroactive effect. In a study in which the interpolated list was presented two, five, ten, or twenty times, retroactive inhibition was found to increase with the increase in the number of repetitions up to the ten repetitions; but for the additional ten repetitions, when the number was stepped up to twenty, there was no further increase in the retroactive effect (99). The greatest amount of inhibition is believed to occur when the degrees of learning in the two tasks are about equal.

Bunch and McTeer (15), in a study of human maze learning, used 110 subjects who learned two stylus mazes, one for the original task and the other for the interpolated activity. The experimental condition tested for its effect on retroactive inhibition was the administration of electric shock on the hand for errors. The retroactive effect of learning the second maze on the retention of the first was less than half as great when the original learning took place with punishment for errors as when it was done without shock. Retroactive inhibition was also greatly reduced when the second maze was learned under punishment conditions. Since the administration of shock for errors was conducive to faster learning with fewer errors, it seems likely that these results are related to those considered in the preceding paragraphs. Punishment for errors may reduce retroactive inhibition because it facilitates learning.

Amount of material learned. *Original task*. Some of the earlier studies showed a decrease in susceptibility to retroactive inhibition as the amount of material of the original task was increased (11). This may have been due not simply to the amount of the material itself but to the fact that the longer lists require a higher degree of learning and are retained better. In a more recent experiment, in which lists of six, eight, ten, twelve, and fifteen pairs of nonsense syllables were used, an attempt was made to control the degree of learning by removing each pair as soon as it had been correctly reproduced three times. The groups that learned the four longest lists recalled almost identical percentages of these lists. It appeared, therefore, that increases in length from eight to fifteen pairs of syllables did not produce decreases in retroaction (86).

Interpolated task. In one of McGeoch's studies (63) it was found that the interpolation of sixteen adjectives after an original list of sixteen had been presented eight times produced more inhibition for relearning after twenty minutes than did the interpolation of lists of eight adjectives. His data indicated that the amount of retroactive inhibition was determined by the relative lengths of the original and interpolated lists.

Another study bearing on the influence of the length of the interpolated task was reported by Twining (102). He used lists of eight nonsense syllables. After the original list was learned to one perfect trial, he presented, during the thirty-minute interval before relearning, one, two, three, four, or five lists ten times each. The recall scores for the original list decreased and the number of relearning trials increased directly as the number of interpolated lists increased. Thus, the length of the interpolated task appears to be one of the factors determining the amount of retroactive inhibition produced by it.

Temporal position of the interpolated task. There has been considerable interest in the question of whether the retroactive influence of the interpolated activity varies with its position within the interval between the original learning and the test of retention. Müller and Pilzecker (1900) and Heine (1914) believed that the sooner the interpolated activity was introduced after the original learning, the greater would be its inhibiting effect (11). Robinson (1920) introduced the interpolated task at four different temporal points of a twenty-minute interval and found no relation between the position of this task and its inhibiting influence. Skaggs (1925) concluded that the retroactive effect is greatest when the interpolated activity comes immediately after the original learning. The results of later experiments have not been in agreement on this point. In some experiments the greatest amount of inhibition has resulted from interpolation immediately after the original learning (91); in others it has resulted from activity placed just before the recall or relearning of the original material (62, 112). The results have sometimes shown no consistent differences in inhibition for different temporal positions of the interpolated task (71).

Since it is found in some experiments that more retroactive inhibition results from some positions than from others, it seems evident that the temporal position of interpolation is one of many determining factors. Presumably the variations in experimental findings are due to the different experimental conditions, including differences in the length of the interval studied and variations in the total complex of variables involved. It has been definitely established that considerable retroactive inhibition may occur when the interpolated task is introduced several days or even weeks after the original material has been learned (15, 67, 68) and that it may occur if this task is introduced at the end of a relatively long interval and just prior to recall of the original material.

Organization. Considerable evidence points to the degree of intraserial integration as a matter of importance in determining the extent to which retention may be impaired by the activity that follows learning. By *intraserial integration* is meant the organization of the unit members of the learning material into a unified whole or pattern by means of the various associations formed between them.

In an attempt to secure gradations in similarity throughout the scale from maximum to minimum similarity, Watson (109) used ten groups of subjects and ten variations of the interpolated task in an experiment on card sorting. Each group first sorted a deck of eighty cards ten times into sixteen compartments numbered to correspond with the numbers on the cards. Then followed an interpolated sorting with changed arrangement and the final sorting with the original arrangement. For group I the interpolated task was exactly the same as the original. This meant that the group simply had additional practice on the same performance. Here was complete similarity, and the effect of the interpolated practice was a slight improvement in the performance. For group II four compartment numbers were changed for the interpolated sorting. This meant that the cards bearing these numbers had to be thrown into compartments different from the ones in which they were placed during the original practice. Group III had eight numbers changed; group IV, twelve; and for group V all sixteen numbers were changed. In terms of materials the first five patterns were completely similar, for numbers were used throughout, but from group I to group V there was increasing change in the organization of movements required. For groups VI to IX letters were substituted for numbers to the extent of four, eight, twelve, and sixteen letters respectively. Here was increasing dissimilarity in terms of materials, while the movement patterns remained the same as in V. The results showed an increase in retroactive inhibition through groups II to V. The change to four letters in group VI did not appreciably diminish the retroactive effect of the interpolated sorting, but from group VI on there was a consistent decrease in retroactive inhibition with the least amount appearing in group IX where all sixteen numbers were changed to letters.

Watson believed that the factor of similarity was insufficient to explain the results and suggested that compatibility also is a factor determining the retroactive effect of the interpolated activity. In his pattern I there was complete similarity and complete compatibility in the identity of the original and interpolated tasks. In V, where all numbers were changed, there was complete incompatibility and complete similarity. The same numbers were used, but each one was associated with a different response. In IX he found complete dissimilarity and complete compatibility because here the interpolated task was entirely different from the original both in materials and in organization of movements. There was, therefore, no necessity for unlearning the original task in order to learn the interpolated task. He points out that when compatibility and similarity are both high, the retention is high; when compatibility is low, even though similarity is high, retention is low; and that when similarity is low and compatibility is high the retention is relatively high.

This investigator found, moreover, that his subjects did not learn the original and interpolated patterns as entirely separate units but that they tended to organize them into a comprehensive pattern that included the two. In cases where some of the numbers were changed, the subjects apparently reorganized the original pattern to include the needed changes in response. When letters were substituted for the numbers, the original pattern was not repeated (the pattern being the same as for V) and so with the increase in the number of letters in the interpolated task the material of the two tasks became less similar. There was then a decrease in the extent to which the interpolated task would disrupt the original organization. These observations led Watson to conclude that "the factor of organization determines the conditions of transfer and inhibition."

Studies by Sisson have thrown light on this problem. In one of them (89) he used nonsense syllables. Some of the lists were made up of syllables known to have high associative value. Others were composed of syllables known to have low associative value. By *associative value* is meant the ease with which subjects are able to find meaning in a syllable by means of some form of association. It was found that when both the original and the interpolated lists had low associative values, there was less retroactive inhibition than when both lists had high associative values. When the two lists differed in associative values, there was less retroactive inhibition than when they were similar in this respect. It seems reasonable to assume that when the associative values are different for the two lists, there would be a greater tendency to organize each into a separate pattern and that the resulting isolation would lessen the chances for interference from the interpolated list at the time of recalling the original. When the lists permit the easy formation of inter-list associations, a high degree of retroaction is to be expected because of the greater possibilities of confusion at the time of recall. Sisson suggests the hypothesis "that where two activities are mutually isolated in the total organization of behavior, by whatever means this isolation can be achieved, retroaction will be reduced to a minimum."

For the purpose of testing this hypothesis, Sisson conducted another experiment (90) in which the learning material consisted of lists of ten adjectives. Two methods of presentation were tested for their bearing on retroactive inhibition. In one the words were presented five times each and always in the same serial order. In the second the words were presented five times, but in random or jumbled order. For the rest conditions the subjects read jokes; for the work conditions the original list was followed immediately by a second list of the same kind. The results from the recall tests showed that the percentage of retroactive inhibition was forty-six for the words presented in serial order and fifty-five for those presented in jumbled order. There were more cases of overt transfer for the jumbled lists than for the serial lists. *Overt transfer* means the shifting of words from one list to the other during recall. It was believed that serial presentation favored a closer intraserial organization of the words, and that the jumbled order made it more necessary to form associations with "the subjects' total memorial organization," including inter-serial associations. According to Sisson's hypothesis this latter condition would result in greater retroactive inhibition.

Sisson's next experiment concerned the temporal position of the interpolated learning (91). A list of ten adjectives was presented five times to each of three groups of subjects. A second list composed of synonyms of the first was presented five times at one of three points in a ninety-six hour interval. The three positions of interpolation were: first, immediately after the original presentation; second, after forty-eight hours; and third, after ninety-six hours and just before retention of the first list was measured. Of the three positions the first yielded the greatest amount of retroactive inhibition, and the middle position produced the least. Sisson states that these results may be explained in terms of "confusion between constellations of associations and memory traces." He points out that in the case of the first position of interpolation, both lists were equally well learned and were probably equally disintegrated over the interval prior to recall. These conditions would be conducive to cross associations and confusions between the two lists. When the interpolated list is presented immediately before recall of the first, its members, being newly learned, would tend to be more closely knit together into a consolidated system, and this condition would tend to minimize inter-list confusions and interference. The position in the middle of the interval, being separated by time intervals both from the learning of the original list and from its recall or relearning, would be conducive to the least amount of interference and confusion between the two lists.

After making a thorough survey of the recent literature on the subject, Swenson (96) states that she favors "an organizational view of retroactive inhibition." This view assumes that the degree of retroactive inhibition is determined by the extent to which relations are built up between the original and interpolated activities and also upon the degree of organization established within each of these activities.

Age and intelligence of the learner. Lahey (54) investigated retroactive inhibition with 3,434 children from eight to sixteen years of age in several schools of Detroit. Lists of twenty-five verbs were used for the original learning material, and for the interpolated tasks the children studied lists of nouns. The periods devoted to the interpolated learning by different groups were four, six, eight, ten, and fourteen minutes in duration. Retention was tested by recall after an interval of seventeen minutes and again after twenty-four hours. The amount of inhibition tended to increase for both intervals as the time devoted to the interpolated learning was increased. For children of the same age the amount of inhibition varied with the level of intelligence. The retention of the children with relatively high I.Q.'s appeared to be less affected adversely by the interpolated study than was the retention of the less intelligent. For children having the same I.Q.'s the older ones were less susceptible to retroactive effects than the younger ones.

Other factors. *Age of the associations.* When the degree of retention is about equal for two sets of material and one of them has been retained over a longer period of time, the retention of the older material will be impaired less by an interpolated activity than the retention of the younger. Thus, there appears to be a connection between Jost's law (page 304) and retroactive inhibition (12).

Mental set. An experiment by Lester (55) showed that instructions given to the subjects tend to reduce the retroactive effects of the interpolated activity, when those instructions lead to expectation of recall, to expectation of the interpolated material, and to an understanding of the possible effects of the interpolated material. An even greater reduction of retroactive inhibition resulted from urging the subjects to make an effort to avoid letting the interpolated material interfere with their retention of the original lists.

Affective toning. A study of Bunch and Wientge (16) of the relative susceptibility of pleasant, unpleasant, and indifferent words to the retroactive effect of interpolated indifferent material showed the least amount of retroactive inhibition for the pleasant words. Frank and Ludvigh (35) used pairs of nonsense syllables for the original learning and then a series of odors was presented to the subjects. The odors were grouped as "pleasant," "unpleasant," and "indifferent" according to results from previous experiments. Recall was tested after an interval of ten minutes. There was better retention when the learning was followed by pleasant odors than when it was followed by unpleasant ones. It appears that the unpleasant odors had a greater inhibiting effect on the recall of the syllables learned prior to the presentation of the odors. These results are in keeping with other studies that show better retention for pleasantly toned materials than for those regarded by the learner as unpleasant.

Order of presentation. McGeoch and McKinney (69) used lists of nonsense syllables paired with nouns as learning material and compared two procedures of presentation with respect to their bearing on retroactive inhibition. In one procedure the order of the pairs within the series was the same in all five of the presentations. In the other procedure the serial order of the paired items was changed from one presentation to another. The results showed the greatest retroactive effect when both the original list and the interpolated list were presented in constant order. The retroaction was less when the order in both lists varied, and it was slight or absent when one of the lists was presented in a changing order while the order of the items in the other list was kept constant.

Methods of measuring retention. Several studies have shown that the indicated impairment of retention by interpolated activity is greater when retention is measured by recall than when it is measured by relearning trials (11, 55). The retroactive effects of the interpolated activity on the retention scores tend to diminish as relearning takes place, and after a few trials there may be no difference with respect to retention between the work and rest conditions. How quickly the retroactive effect disappears seems to depend on such conditions as degree of learning and the similarity of the two tasks (64*b*). These findings indicate the practical importance of reviews as a means of counteracting the impairment of retention by the activities that follow learning.

When the recognition method has been employed for measuring retention in experiments designed to investigate retroactive inhibition, in some cases it has revealed no difference in retention between the work and rest conditions. When this method has yielded evidence of retroactive inhibition, the amount indicated has usually been small. This is in keeping with the fact, mentioned in an earlier section, that higher percentage scores of retention are usually obtained by the recognition method of testing than by the method of recall. It appears that recognition is affected in essentially the same way as recall, though to a smaller degree, by the activities of the interval (11, 72, 120).

Theories. Two major theories have been advanced to explain retroactive inhibition. The first, known as the *perseveration theory,* was offered by Müller and Pilzecker (1900). According to this theory the neural activity involved in learning perseverates, or continues for a time after practice has ceased. This perseverating process, it is assumed, strengthens retention by consolidating and fixating the neural residues of learning. The activities following learning would tend to suppress such a consolidating process, or prevent it from running its full course; while rest would favor perseveration and make possible a more complete realization of its advantages. The fact that activities coming immediately after learning have often been found to produce more retroactive effect than those coming later in the interval is cited as evidence in favor of this theory.

However, the perseveration theory does not adequately explain the retroactive effect of activities that follow learning by several days or weeks, nor the detrimental effect on recall produced by activity placed just before the test and after a relatively long interval. It does not account for the greater amount of retroactive inhibition when the materials and methods of the original and interpolated tasks are similar than when they are dissimilar. Against this theory, also, is the fact that some forms of activity, even though fairly strenuous, and placed immediately after the learning, do not produce any appreciable amount of retroactive inhibition (60).

The second theory is known as the *transfer theory*. It has gained favor as new experiments have brought to light more and more facts that are not covered adequately by the perseveration theory. The transfer theory holds that the results of the original and interpolated learning become mixed and confused so as to produce more or less disruption of the original pattern and interference with the reproduction of the original material. In favor of this theory are the findings in regard to the relation of degree of similarity to the amount of retroactive inhibition, and many other facts, such as the overt transfer in reproduction of items from one list to the other and the decrements in reproduction when the interpolated task comes just before reproduction is attempted. The transfer theory regards retroactive inhibition as a form of transfer of training, the topic of the next chapter. As such it is a matter of negative transfer.

Prevention. The many studies on retroactive inhibition have shown that retention may be impaired by the activities following learning. They indicate that to conserve the results of our learning, we should, after a period of study, rest for a few minutes before plunging into another study task. If one period of study is to be followed immediately by another, we should arrange our schedule so that we may switch to the lesson that is least similar to the one on which we have been working. To keep retroactive effects at a minimum, we should strive for a high degree of learning and for meaningful organization of the units of study, avoid studying another subject just before tests or examinations, and review in order to secure the advantages of relearning.*

REMINISCENCE

Contrary to the initial fall of most curves of measured retention it sometimes happens that retention scores increase after a period of rest. This increase in retention during the interval is called *reminiscence.*

Experiments of Ballard and Williams. As early as 1913 an experiment that revealed this phenomenon was reported by Ballard (2).

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* For a more complete account of recent studies on retroactive inhibition and a discussion of the educational significance of their results see the monograph "Retroactive Inhibition; A Review of the Literature," by Esther J. Swenson (96).

His subjects were children in some of the elementary schools of Southeast London. The materials used for learning were thirty-four lines from "The Ancient Mariner," and seventy-two lines from "The Wreck of the Hesperus." The time allowed for learning was not sufficient for complete learning. A test was given at the end of the study period and again after intervals varying from one to seven days. For the first five days the delayed retention scores for "The Wreck of the Hesperus" were higher than those obtained on the test for immediate recall. After the fifth day the curves of retention dropped below their original height. For "The Ancient Mariner" the retention curve reached its peak after an interval of two days. After three days the curve was still above the level for the immediate tests, but after four days it dropped below that level.

Later a similar experiment was conducted by Williams (114). His subjects were Chicago school children and college students. The average scores for delayed recall of a partially learned poem were higher than for the immediate recall in the case of children in the third and fourth grades, and this was true to a lesser degree for sixth and seventh graders, but not for high-school and college students.

Ward's experiment. That reminiscence occurs during short intervals following learning was demonstrated by Ward (107). His subjects repeated lists of twelve nonsense syllables to the point of seven correct anticipations and to the criterion of one perfect recitation. A measure of retention was secured in the control series after six seconds, and for the experimental series after various intervals from thirty seconds up to twenty minutes. With both degrees of learning, reminiscence was found for the shorter intervals. For partial learning the relearning scores were better after thirty seconds than after six seconds. For complete learning the retention as measured by relearning was highest at two minutes after learning. The results indicated a decline of retention after the first two minutes. It was found that a greater amount of reminiscence occurred for the syllables near the middle of the lists than for those near the ends, a fact which is significant for the explanation of this phenomenon.

Hovland's experiments. Working along the same lines, Hovland verified the findings of Ward by showing that better recall scores are obtained and fewer trials are required for relearning when there is a rest pause of two minutes between learning and testing than when the test of retention is given immediately after learning. In a series of experiments he has demonstrated that more reminiscence occurs when learning is massed than when it is distributed (45), that more reminiscence follows the learning of a twelve-syllable list presented at a two-second rate than a list presented at a four-second rate (46), that for serial lists with massed practice the greatest amount of reminiscence is obtained for items near the middle of the lists (45), and that while reminiscence appears for a serial list after a single presentation (46), little or none is found in the case of paired-associates learning (47).

Three important differences between the experiments of Ballard and Williams and those of Ward and Hovland are to be noted. First, the former studied the increase in retention for periods extending over several days, while the latter studied reminiscence during short intervals ranging from thirty seconds to twenty minutes. In the second place, the Ballard-Williams experiments employed an immediate recall test, and after an interval the same subjects were tested again on the same material, while in the Ward-Hovland studies the subjects were tested immediately only in the control trials. In the reminiscence trials a test was given only after a rest pause. This procedure avoided the influence of immediate recall on the scores of the post-interval test. The amount of reminiscence was found by comparing the retention scores from the immediate tests with those obtained from the delayed tests. In the third place, meaningful materials were used by Ballard and Williams, while Ward and Hovland employed nonsense syllables.

Motor learning. Reminiscence has been found to occur for motor learning as well as for verbal learning. In experiments with a pursuit rotor it has appeared over an interval of ten minutes, which is longer than for verbal learning in experiments where the experimental trials did not include an immediate test (20).

What accounts for reminiscence? Various theories have been advanced to explain this apparent contradiction of the law of forgetting (45, 47). We shall not attempt here to describe and evaluate all of these. We shall, however, mention some of the more cogent suggestions of why test performance is sometimes better after a period of no formal practice.

School children tested by means of standardized tests before and again after the summer vacation sometimes show a gain after the summer months without school (88). This is most likely due to the additional knowledge gained from sources outside the school, and probably should not be considered a matter of reminiscence. In the absence of controls, however, we cannot be certain that such gains are not in some measure the result of this phenomenon.

Some investigators have attributed reminiscence to *rehearsal* or review during the interval (114). That rehearsal, voluntary and involuntary, does often occur where suitable means for preventing it are not used we may be sure; and when it does occur, it operates as additional learning and its effect is to enhance later recall. However, a check on this point was made by Grace McGeoch (58). She had a large number of school children study a poem for five minutes and then tested them immediately and again after twenty-four hours. The children were asked whether they had reviewed or thought of the poem during the interval. Out of a group of 295 children eighty-four per cent admitted some form of rehearsal, but for the sixteen per cent who disclaimed it there was evidence of as much reminiscence as for those who admitted it. Though there was no way of ascertaining the accuracy of the children's reports, this investigator regarded them as reliable and concluded that review or revival during the interval was not the full explanation of the better recall scores after the twenty-four-hour interval. Her conclusion is supported by the findings of Ward and Hovland who had their subjects give color associations or name colors during the interval to prevent rehearsal. And, as Hovland points out, even if there had been rehearsal in his experiments in spite of these precautions, its effect would not account for the difference in reminiscence following massed and distributed learning (45, 107).

The suggestion has been made that the better recall and relearning scores obtained after an interval of rest may be due to the *removal of fatigue*. The presence of fatigue is detrimental to recall and its elimination may be expected to favor better test performance. But this is not a satisfactory explanation of reminiscence in the light of some of Hovland's findings. He found that reminiscence occurred after one presentation of a serial list but not after paired-associates learning. We should expect little fatigue from one reading of a twelve-syllable series, and as much from a paired-associates list as from a serial list.

We often have the experience of being baffled in our attempt to recall a name or the answer to a question only to have it appear, as it seems, spontaneously at a later time. The particular stimuli or other conditions may be less favorable for recall at one moment than at another. For this reason a recall test does not always reveal fully what the individual has retained or what he may be able to recall under different circumstances. Brown (14) has shown experimentally that items not recalled in one test sometimes appear in a second test without any additional learning. If we combine this observation with the fact that recall is a form of review for the items recalled and that it therefore strengthens the associative tendencies operating in recall, it becomes evident that the *immediate test* may be a factor responsible for the appearance of larger scores in a later test. The immediate recall strengthens the grip on those items which are recalled so that they will be retained better, and when the new items in the next recall outnumber the ones lost by forgetting there will be a larger net score from the second test. It is probable that this accounts for some of the gains called *reminiscence* in the case of the studies with the longer intervals, where the subjects were tested right after learning and retested at a later time. This factor, however, is ruled out of the experiments of Ward and Hovland, since the subjects whose scores were obtained after a short rest pause were not given an immediate recall test.

In the light of the available facts the explanation that seems most satisfactory is the one which attributes the gains of the interval to the *removal of various inhibitions* which are built up during learning and which operate against immediate recall (45, 47). These inhibitions include the effect of associations between remote or nonadjacent members of a single serial list, the proactive interference of the first part of a list with the following portions, and the retroactive effect of the last part on the preceding sections. When several lists are learned in close succession (massed learning) there is the additional possibility of interference, proactive and retroactive, between the various lists. Since the remote associations and interferences are not so strongly established as the associations between the adjacent members, they presumably are forgotten faster. This difference in the rate of forgetting, as McGeoch and others have pointed out, would leave the functional trends for recall freer to operate after an interval of rest than at the conclusion of learning (64*c*). This view is supported by the fact that the greatest amount of reminiscence is found in connection with those conditions of learning where the most interference occurs, namely, in the middle of a series more than at the ends, with massed learning more than distributed, and with a serial list more than with a paired-associates list in which the order of the pairs is varied during learning.

Whatever the true explanation of this phenomenon may be, the fact of reminiscence seems to be definitely established. It is a special feature of retention and as such it must be incorporated into our conception of forgetting. It is to be regarded as a normal result of certain conditions of learning, which in no way invalidates the findings of the earlier studies showing an initial rapid fall of the retention curves. In these earlier studies the conditions of learning or testing procedures were different. In the typical Ebbinghaus curve, for example, the first point of measurement was at the end of an interval of nineteen or twenty minutes. In Ward's experiment it was found that after two minutes the curves began to fall. In Hovland's experiments the subjects were tested for retention after a pause of two minutes. When the first test was given only after the longer intervals, the amount of forgetting would conceal any reminiscence that may have taken place during the first few minutes.

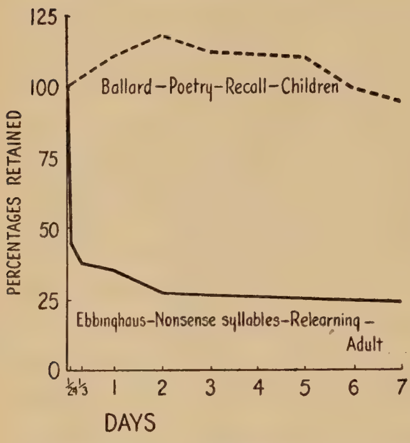

Fig. 30. The dotted line is a curve of retention based on the results of the Ballard study. The solid line is the Ebbinghaus retention curve.

In a recent study of forgetting during the first three minutes sets of six nonsense syllables were presented serially and the subjects were asked to write down what they had seen after intervals varying in length from zero to 180 seconds. The reproduction scores fluctuated for the various intervals, with peaks at twenty, thirty, and 180 seconds. The highest peak came at the end of the twenty-second interval (73).

It is to be remembered that reminiscence is found only when learning is incomplete, that is, when the immediate test scores from which gains or losses are calculated show less than 100 per cent retention, and that in the cases where gains were found for the longer intervals, as in the Ballard experiment, the influence of the immediate test is to be considered. Incomplete learning with an immediate recall test followed by a second test is a procedure quite different from complete learning with a test of delayed recall only. So we find in reminiscence no fundamental contradiction of the Ebbinghaus type of retention curve, but a phenomenon that fits naturally into the total picture of retention.

McGeoch and others have called attention to the similarities of the conditions under which reminiscence appears and the procedures of distributed practice. Both involve a period of rest after practice, and in both this rest pause facilitates test performance. It is felt, however, that at present the evidence is insufficient to warrant the conclusion that reminiscence and the advantages of distribution of practice are derived from the same principle (64*d*).

QUALITATIVE CHANGES OF THE INTERVAL

In addition to the quantitative aspects of retention which we have been considering, a number of qualitative changes in the retained material take place during the interval. In recitations and examinations children show not only a loss of much that they have learned but also various imperfections and deviations from the original material in what they reproduce. From the standpoint of school learning it is obvious that this feature of retention is quite as important as the quantitative loss. The facts of quantitative decline are significant for all cases of rote learning, such as the memorizing of the arithmetic combinations, spelling, and verbatim learning of poems and rules, but the qualitative changes which include insertions of new elements, transpositions, distortions, substitutions, omissions of particular details, and the like, are common, and for the teacher who is trying to build up topical understanding they are of vital concern.

Intrusions of the interval. The studies on retroactive inhibition have shown that the insertion of a second learning activity between the original learning and recall results in interference, which impairs retention. But besides this it is found that sometimes items from the interpolated lists or learning materials appear as erroneous responses during the recall of the original material (74). Thus, we find that from experiences occurring during the interval various elements may be blended with what has been learned, so as to cause errors in reproduction. A classroom illustration would be the case of a child who reads two stories in succession, and then into his reproduction of the first inserts characters or events from the second. An example from everyday life would be the case of a person who sees an automobile accident and afterwards hears another witness tell something about it which he himself did not observe, and who later in court testifies to having seen what he only heard from the other witness after the accident.

The memory image. A number of the early studies of memory were concerned with the changes in the memory image which occur during the lapse of time. These studies were based on the subject's introspection and his reports. In one such study a color or gray of a certain brightness was exposed for five seconds. After an interval of one minute or five minutes another color or gray was shown, the latter being equal to the first in brightness, or slightly lighter, or slightly darker. The subjects were asked whether they had a visual image of the original stimulus and if so whether the second stimulus was similar to it in brightness, or lighter, or darker. Correct responses were sometimes given when no visual image appeared, but where the images did appear, it was found that in daylight they tended to grow lighter and in a dark chamber they tended to grow darker during the interval. It was concluded that the nature of the retinal stimulation during the interval was related to the change that occurred in the visual image (5). This study demonstrated that the experiences of the interval cause qualitative changes even in very simple memories.

Stories and other comprehended materials. When children or older subjects are asked to reproduce stories or other topical material, a number of discrepancies are usually found when their reproductions are compared with the original. Omissions, alterations, and additions are frequent. Points not essential to the plot as understood drop out. Uncomprehended elements are omitted. The general meaning of the story or topic dominates the reproduction, and elements that were not incorporated into the general meaning structure are not recalled. Where gaps occur in recall the subject fills in from his own general fund of experience. Thus, his account is more than reproduction; it is in part a creation (3).

When a story is passed along from person to person the accumulation of alterations sometimes produces a remarkable transformation that bears little resemblance to the original. In one study of story remembering the experimenter submitted the story by the method of serial reproduction to six boys and six girls in the seventh and eighth grades. The first boy read the original and reproduced it after five minutes. His reproduction was read by the second boy who in turn passed his reproduction on to the third, and so on through the group. Titles and names of persons and places were found to be the most unstable elements of the story. The story shortened as it passed along. Minor details dropped out first, incidents and events were transposed, and the language was changed to patterns more familiar to the members of the group (76).

Objects. The memory changes for a particular object tend to follow a course similar to that found for stories. Minor details tend to drop out rather early. The recalled object tends to become less distinctive and to approach a type according to the individual's general experience with many objects of the class to which the particular one belongs. Certain essential features become stereotyped. For example, one sees an elephant at a circus; as time passes the particular characteristics of this elephant disappear from memory, and what remain are the features common to all the elephants one has seen. If, however, the object possesses some unusual feature that receives special attention and arouses interest, this feature may not only persist in memory but it may dominate the recalled structure. A young boy had noticed for the first time the front sight on the end of a gun barrel and was much interested in its purpose. Later he made a drawing of the gun from memory. The sight was drawn altogether too large in proportion to the other parts. If upon meeting a stranger one notices that the individual has a large nose, the nose may grow still larger in memory.

Verbal reactions play an important role in altering memories. A verbal description, labeling, or association may not only aid retention, but may be responsible for a shift away from the original impression. Upon noticing a friend's dress, for example, one may say "light blue." Now there are many shades of light blue, more than we have words to label precisely. In recalling the color of this dress one thinks "light blue," and the meaning is likely to be the average light blue ordinarily denoted by these words. The color in recall then may be somewhat lighter or darker than the color of the dress.

Pictures and nonsense figures. In a number of studies on this problem, pictures and nonsense figures have been used as learning materials, and retention has been tested after an interval by means of drawings. As in the case of retelling stories, this test is not a measure of retention alone. In addition to what is actually recalled, such drawings represent the creative activity by means of which the subject fills in the gaps in his recall in order to complete the picture. The results of such studies indicate that the details tend to drop out sooner than the main outlines of the picture or figure, and that there is with the lapse of time a drift toward a schematized type. Sometimes the figure changes so that it comes to resemble something else. This appears, in some cases, to be due to verbal labeling or to an associated idea. For example, if the subject sees a nonsense design and thinks, "It looks like a cat," his reproductions are likely to look more and more like a cat as time passes (26). Under repeated reproductions an irregular or unsymmetrical figure tends to become more regular or to shift toward symmetry (79). Figures resembling to some degree a more familiar form tend to be drawn more like the familiar form. Lines that in the presented figure are fairly close to parallel, vertical, or horizontal tend to be drawn as parallel, vertical, or horizontal (53). A peculiar feature of the picture may be exaggerated, and certain writers partial to the Gestalt point of view hold that under repeated reproductions figures tend to improve through structural change (118).

It is clear, therefore, that qualitative changes in the material learned, as well as changes in the amount retained, take place during the interval following learning. These changes are due to previously acquired knowledge, to experiences which precede learning, to verbal description and analysis, and to various events or experiences of the interval.

They are responsible for errors in reproduction and for various deviations of the reproduced contents from the materials presented for learning.

Retention of School Learning

It is sometimes felt that the use of nonsense materials in the laboratory precludes application of the findings to school learning. However, a comparison of the results of school learning with those obtained from laboratory experiments shows that the same fundamental principles apply in both situations. After all, the materials presented for learning in school are nonsense materials until some learning has been done on them. The fact that they are meaningful simply means that they have already been learned to some degree, and the study of them means additional learning. The use of nonsense materials enables us to start nearer the zero point and it makes possible a more exact accounting of the many factors that contribute to learning and retention. The writer agrees with the suggestion made by Stroud "that differences in the materials employed in the two fields of research (the laboratory and the classroom) are not so serious as those involving the use that is made of them. The fact that lists learned in the laboratory are usually made up of nonsense syllables does not present so great an obstacle to applicability in school as does the fact that the learning activity is memorization" (95*a*).

Studies on the rate of forgetting of school subjects usually show a negatively accelerated rate of forgetting of the same general form as the typical Ebbinghaus curve. This has been found in studies on the retention of history, physics, chemistry, botany, and zoology. Of course, as we have already noted, one usually retains a greater percentage of meaningful material than of nonsense material; the curve of retention does not drop so swiftly for meaningful material.

When children or students are tested after a considerable period with no formal instruction in a subject, a big loss is indicated for factual content. In a study by Greene (42) 1,064 university students were given in October the same examinations they had taken at the end of three courses the previous June. The repeated examinations showed a loss for the four months of about half of the information that had been reported correctly in the June examinations. Similar results have been reported by other investigators.

Eikenberry (32) gave standardized tests to college seniors on subjects studied in high school but not continued in college. The results were best for American history, ancient history, and geometry, followed in descending order by Latin, chemistry, and physics. It was believed that the better showing in history and Latin was due to the fact that the work in college afforded more instances of review, additional learning, or use of materials in these fields than for other subjects. The relatively high performance in geometry, Eikenberry suggests, was probably due to the fact that the test was not merely a test of information, but also of ability to reason.

Retention during the summer vacation. In a number of studies children have been tested in various subjects at the end of the school year and again after the summer vacation. The results sometimes show losses, sometimes no change, and sometimes they actually show a gain. Reports on reading for the first three grades vary from slight losses to slight gains, and for the intermediate grades the trend toward gains appears to be stronger than toward losses. Gains have been reported for history and literature. A study of the retention of American history by junior-high-school pupils indicated a loss of about thirteen per cent after four months, approximately nineteen per cent after eight months, and about twenty-three per cent after one year (13). Losses are found for spelling and arithmetic, particularly for the computational skills. Bright pupils have been found to gain more or lose less than their less intelligent classmates (88, 95). The gains reported may probably be attributed to practice or additional information picked up during the summer, since they are found most often in the subjects which may most easily be reviewed, practiced, or supplemented by incidental learning. Where actual losses occur, it sometimes requires several weeks after school reopens to recover from the setback caused by forgetting.

Factual information compared with other learning outcomes. There is a considerable amount of evidence which indicates that factual information is forgotten faster than the ability to explain, interpret, and apply general principles. Computational skills in arithmetic have been found to deteriorate more over the summer vacation than the ability to solve problems in arithmetical reasoning (88). College seniors who had not studied geometry since high school did better on a geometry test that was in part a test of ability to reason than they did on tests in chemistry and physics (32). Results of a test in zoology given to eighty-two students at Ohio State University fifteen months after the completion of the course showed the greatest loss in technical material or information and no apparent loss in ability to apply to new situations principles that had been learned (103). In terms of percentages of the gains made by boys and girls during a course in high-school chemistry, retention after one year for five selected objectives of the course was found by retest to be as follows: application of principles, ninety-two per cent; selection of facts, eighty-four per cent; balancing equations, seventy-two per cent; symbols, formulas, and valence, seventy per cent; and terminology, sixty-six per cent (36). Other studies have shown that retention of the substance of paragraphs, as measured by recognition of sentences that summarized the meaning of the paragraphs, is superior to verbatim retention as measured by the recognition of sentences drawn verbatim from the text (31, 33).

Attitudes, also, are apparently more permanent acquisitions than factual material. The evidence that a number of important learning outcomes are more stable and lasting than factual information and verbatim learning is encouraging to the educator. It should not, however, be construed to mean that factual teaching is altogether unnecessary, for such teaching has its place in fostering the development of concepts and the comprehension of principles. These findings bring to our attention again the need for clearly defined teaching objectives, and suggest that our tests, as well as our teaching, should be suited to these objectives.

Tests and retention. The recall of materials learned is a form of review. It helps to consolidate gains from study or practice. Tests and examinations, therefore, should have a salutary effect on retention, both as a means of stimulating reviews in preparing for them and for securing recall while taking them. Several studies on this question have been reported.

A study of retention under various testing procedures was made by Spitzer (93) with 3,605 sixth-grade pupils as subjects. The learning material consisted of a printed informational article, which was studied for eight minutes. Some groups were tested immediately after learning and retested later. Others were tested at intervals varying from one to sixty-three days. The groups tested immediately made definitely higher scores on the later tests. Without recall forgetting was rapid during the first day. Pupils of superior ability did not forget so rapidly as those of lesser ability. The data clearly indicated that the recall in tests given immediately after learning was a distinct aid to retention.

Similar results have been obtained in other studies. In one by Edwards and English (31) five experimental groups of college students read and heard read an unfamiliar selection. They were then tested for verbatim and summary retention. One group was tested immediately after learning and again after sixty and ninety days. The other groups were tested after five, ten, fifteen, and twenty days respectively.

The immediate test produced higher scores in the later tests for both summary and verbatim retention.

The immediate tests used in the studies mentioned above provided a vigorous form of review. Coming immediately after learning, their effect on retention is in line with the earlier findings of Gates, whose data showed that memorizing is more efficient when part of the time is spent in reciting than when all of the time is spent in reading the materials (37). These investigators have demonstrated that the advantages from practicing recall found by Gates for memorizing may be secured for substance learning by the use of objective tests. Spitzer's tests consisted of multiple-choice questions; Edwards and English used true-false recognition questions. These authors advocate the more frequent use of tests in the school as a means of promoting better retention of what is learned.

Reviews and retention. Since these immediate tests furnish a form of immediate review, the advantages they afford are in keeping also with other findings relative to the value of early reviews. For some time it has been advocated, in view of the negative acceleration of forgetting, that to secure the best results in the way of retention one should review frequently at short intervals soon after learning and then after longer and longer intervals as the temporal distance from the original learning increases (57). This appears to be a sound principle in general, particularly for rote learning. But if a child has just read a story or a lesson in history, which he clearly understands, an immediate rereading may be pretty dull and less stimulating than a multiple-choice test over the materials read. A review may be made by recall as well as by rereading. Tests provide review by recall.

It has been found that the most advantageous temporal position differs for these two forms of review. Sones and Stroud (94) made a comparison of the effectiveness of review by multiple-choice testing and by rereading for three different temporal positions within an interval of forty-two days following learning. About 1,300 seventh-grade pupils spent twenty minutes studying an informational article on the history and methods of making paper. Ten-minute reviews were given by testing or by rereading for different groups on the first and third, on the eighth and fifteenth, or on the fifteenth and seventeenth days after the original learning. When the reviews occurred on the first and third days, the review by testing was significantly more effective than the review by rereading; but for the reviews placed later in the interval the advantage was in favor of the rereading. The difference in favor of rereading was, moreover, greater for the positions farther removed from the original learning. It appeared that the effectiveness of rereading was affected very little by its temporal position, while for testing the effectiveness was greatest in the early positions and decreased as the time between learning and review testing increased. The farther the review is removed from the original learning the more, of course, will forgetting have taken place; and, therefore, less and less of the content will be available for review by testing as the elapsed time increases.

Procedures for securing good retention. Efficient management of the learning process calls for a consideration of the degree of persistence needed, and the employment of procedures conducive to good retention where permanence or long-time persistence is indicated. Spelling, the fundamental processes in arithmetic, and word recognition call for permanent retention. In subjects such as history, social studies, and literature the exact retention of specific details is not so essential. The specific facts serve their purpose when they provide an understanding of general principles or trends. The substance of a paragraph or book may be effectively retained without the specific details which contributed to its mastery. A person may have a sufficiently good understanding of our Civil War without being able to reproduce the dates and the names of generals of all the battles mentioned in the text. One may have a good concept and still not be able to recall all the experiences that helped to build up the concept. The needs of the individual should guide us in judging the degree of permanence to be sought. The introductory course in a science, for example, should not be taught as though every member of the class were going to become a specialist in that field.

In the foregoing sections we have considered a number of factors that influence forgetting. We cannot control all of these at will, but the findings of many studies on retention point to certain practices which may be relied upon to aid retention. It is noteworthy that these for the most part have to do with the methods and procedures of learning. About all that can be done to promote retention after learning is to avoid the interferences that operate against it. The following are some of the procedures for securing good retention:

1. Make the material to be learned meaningful. Help the pupil see what it means to him. Relate it to his experience, to other topics studied, and to future use.

2. For permanent and exact retention secure an adequate degree of overlearning. Drill is essential for permanence, and overlearning prevents the material from dropping below the threshold of recall during the early period of rapid forgetting.

3. Apply the principle of distribution of effort. Avoid cramming. This helps to prevent the deleterious effects of fatigue and interferences due to the piling up of too much material at a single sitting. It allows for the effective operation of any processes of consolidation which may continue after practice is discontinued.

4. Make liberal use of reviews. In general, reviews should come fairly soon after learning and be repeated after increasing intervals. In the case of substance learning, tests of the multiple-choice type may be used effectively if placed immediately or soon after learning. For reviews after several days or weeks the rereading form of revival is indicated. Tests should be regarded and used as means for promoting retention and not merely as instruments for measuring it.

5. Prevent retroactive inhibition by periods of rest after learning, or by shifting to a different type of work.

6. In the case of substance learning stress generalizations and summarize at the end of lessons, divisions, or lectures.

Retention of Motor Skills

In the case of motor skills the loss due to lack of practice corresponds to the forgetting of verbal materials. It is commonly believed on the basis of informal observations that motor skills, or perceptual-motor acts, are retained much better than ideas. A person who has not tried to ride a bicycle for ten years gets on one and rides away with little or no difficulty.

In certain cases motor skills do seem to persist remarkably well without practice. Yet we know that the finer coördinations in such skills as piano playing deteriorate without practice. The apparently greater tenacity of some acts of skill as compared with ideational or verbal learning is probably due to the greater degree of learning and more extended practice in the case of the former. The activity of riding a bicycle, for example, ordinarily receives more practice and covers a longer period of time than is given to a poem or to an oration which is learned to meet the demands of a particular occasion.

But these casual observations on unmeasured learning cannot be expected to throw much light on the question. In experiments in which the retention of maze learning is measured by relearning, the retention curves usually show about the same sort of negative acceleration as the typical curve for verbal retention (100). In cases where the degree of learning is about equal for motor habits and verbal materials there is probably little difference between them in retention.

McGeoch and Melton (70) compared retention of maze habits learned to the criterion of one perfect trial with the retention of nonsense syllables learned to the same criterion. Retention was measured by relearning after seven days. They found retention, when measured in terms of the number of trials required for relearning, to be superior for the nonsense syllables. In terms of relearning times and errors, however, neither material was consistently superior. In this study the methods of learning were different. For the syllables the anticipation method was used, while for the mazes the procedure was one of trial and error.

The methods of learning were more nearly equated in an experiment by Van Tilborg (106). He employed a finger maze and a mental maze. By means of the latter he secured a trial-and-error method in verbal learning. The procedure here was to present serially a set of twenty pairs of nonsense syllables. One of each pair was "right," and the other was "wrong." As each pair was pronounced by the experimenter the subject had to choose one. If the right one was chosen the next pair was pronounced. If the subject chose the wrong one the experimenter pronounced the correct one. The process was continued until the subject could select the right one every time. These choices were comparable to the choices which have to be made between paths in learning a maze. In the study on retention the two mazes were learned to the same criterion of two consecutive perfect trials. The results from a relearning test after fifty-one days indicated that retention was about the same for the verbal mental maze as for the finger motor maze. The saving in trials and in errors was slightly greater for the mental maze, but for time saved in relearning there was a slight advantage with the finger maze. The author did not consider the differences great enough to be conclusive and believed the results were in keeping with the view that motor and verbal habits are retained equally well if they are learned equally well.

RECALL

The nature of recall. In recall an earlier function is renewed and runs its course without the aid of certain stimuli upon which it originally depended. For memorized verbal materials it means recital in the absence of the stimulus-pattern presented to the senses during learning. The recollection of an event or object is frequently mediated by centrally aroused mental images, which carry the meaning originally conveyed by the sensory pattern in perception. To a very large extent recall is accomplished by means of words. Sometimes words and imagery are both employed in reproduction of earlier functions. Visual images appear in recall more often than images representing the other senses.

Memorial recall and verbal recital are in many respects like the renewal of practiced motor functions. We may take for illustration the case of typewriting. Say we have a student who is a skilled typist, but she is now listening to a lecture in the history class. Where are the finger movements she made at the typewriter an hour before? We do not suppose they exist in the subconscious mind or any other reservoir waiting to be taken out. We do not regard these movements as existing at all as movements during the interval when no typing is being done. What this student has and carries through the interval is not the movements themselves but the trained neuromuscular mechanism for making them. This mechanism was trained by earlier practice, and the movements will recur under the appropriate conditions, which throw this mechanism into commission. Ideational recall is like this. Perception or other functions involved in learning leave their impression on the nervous system in the form of functional trends. These trends, when aroused, determine the nature and course of the functional event which is recall or reproduction.

Conditions of Recall

Stimulus. Ordinarily, if not always, recall is touched off by a stimulus of some sort. We use the term *stimulus* here in its broader connotation. It may be something we hear, see, or perceive through other sense channels, or it may be an idea that causes us to think of some event or object connected with it in our previous experience. In paired-associates testing the first term of the pair presented for learning is used as a stimulus. When it is presented, the subject supplies the second term. In serial reproduction each term serves as a stimulus for the arousal of the succeeding one. In the classroom the stimulus most commonly employed to induce recall is the question. To be an effective instrument for recall the question must contain meaningful elements connected during learning with the words or ideas to be reproduced. It should be clear and definite. Failure on the part of the pupil to give the expected answer may be due, not to his lack of knowledge, but to the ambiguous phrasing of the teacher's question.

The neural trend. The neural trace left by learning tends, if not renewed, toward obliteration because of the more or less continuous activity of the brain. This weakening of the trace makes it less effective for recall. This fact we have considered under the topic of forgetting.

But for recall to be possible this obliteration of the neural trace must not have gone beyond a certain point. This point is called the *threshold of recall*. When the trace has weakened beyond the recall threshold it still may be strong enough for recognition. Sub-threshold retention is measured, as we have seen, by the relearning method. When forgetting has proceeded to the point where recall is impossible one may still relearn in less time than was required for the original learning.

Set and bodily states. Often one has many possible responses for a given stimulus. In such cases the individual's set and other subjective conditions may affect the course taken in recall. Hunger is likely to steer recall toward food. Thirst makes one think of water or places where it may be obtained. One's desires, ambitions, and purposes exercise a directive influence. Fatigue is detrimental to recall and may prevent it unless the associative tendencies are very strong. Students should get their usual amount of sleep and recreation prior to examinations in order to do their best on them.

Emotional excitement. Strong emotions tend to inhibit recall. For clear thinking one needs a calm mind. One does well to hold his tongue in anger, and to refrain from making important decisions when incensed or greatly frightened. Many students have a fear of examinations. Their fear is a handicap that prevents them from doing their best. It may stem from the teacher's reference to the examination as a day of reckoning in which all miscreants will get what is coming to them; or it may come from previous failure, or other unhappy associations. As teachers we should do our utmost to prevent and, if need be, remove the fear of examinations. If a child is made to feel that a test provides an opportunity for him to find out and show how far he has advanced since his previous test, the chances are good that he will gain satisfaction, even enjoyment, from taking tests.

Reproductive inhibition. Failure to recall is sometimes due, not to the absence of sufficiently strong associative tendencies, but to the presence of two or more of about equal strength which interfere with each other and block recall. This blocking is called *reproductive inhibition*. An example would be a student's inability to respond while taking a free association test. The tester calls out a word (stimulus) and the student responds with the first word that comes to his mind. Usually familiar words are used. The test runs along smoothly for a while. Then a word—suppose it is *apple*—is given, and after a long delay the student grins sheepishly and says, "I just couldn't think of anything." Now obviously he had a number of associations with the word *apple,* but still no response was forthcoming. After a few moments he would probably be able to give several responses to that word. One may experience this inhibition when, without warning, he is called upon to give a quick statement on some question about which he has a great amount of information. It may prevent a student from answering a question in class even though he is thoroughly prepared. A teacher should be careful not to accuse a pupil of lack of study when his failure to respond is due to reproductive inhibition. A rephrasing of the question or a casual remark will usually be sufficient to break up this temporary blocking of recall.

RECOGNITION

Perceptual recognition. Recognition occurs in both perception and recall. When we see a person on the street whom we know, the experience is different from seeing a stranger because recognition is involved in our perception of the acquaintance but not of the stranger. We recognize objects and places as well as persons. In recognition there is added to the object-meaning the meaning that the person or thing is known. The person recognized is to us a person whom we place by name, or by some other special mark of identification, as one whom we have met on some previous occasion, or as one who occupies a certain position. The object recognized is one that is identified in certain respects through our previous experience with it. A place is recognized when we realize that we have been there before and know that it is not new to us. The essential feature of recognition is the meaning that we know the particular object perceived. There is in the experience the element of familiarity.

Recognition and learning. A thing cannot be familiar except through previous experience. Recognition is therefore a learned performance. Perceptual recognition differs from recall in that the object of a previous perception appears again and is identified in terms of what we have previously learned about it, whereas in recall the object is absent and we bring it to mind through the medium of something connected with it in our previous experience. We have then in perceptual recognition a perception that has been modified by learning; and the modification is by way of the inclusion of the element of familiarity and the meaning that the object is known.

The means of recognition. The familiarity reference in perception is provided by various means. It is often mediated by an established associative tendency that is aroused by the perception and that brings to mind the name or connections of a person, the general surroundings of a place, or the circumstances under which the person or object was previously encountered. But recognition is possible without the intervention of any associated idea. It is believed that in such cases organic sensations and bodily reactions contribute the feeling of familiarity, the sense of ownership, or relief from tension found in recognition.

Degrees of definiteness. There are different degrees of definiteness in recognition. They range from the vague feeling of familiarity with no definite identification, to precise and unequivocal definition of identity. For the purpose of illustration let us suppose you have just seen a person in the waiting room of a railway station. Indefinite: you have a feeling that you have met or seen that person before but you cannot place him at all. Slightly more definite: you know that he is a student from a nearby college, or you place him as a teacher in town for the convention. Definite: you know he is Ellison Atwater, the mayor of Adamsville.

The lapse of recognition under repetition. The tendency of the organism to economize on its psychological functions by short cuts, ellipses, reductions, and elimination has been noted in several connections. In the case of action we have seen that under repetition the task tends to drop out in favor of bodily controls, and perception dwindles to the barest essentials as action becomes more and more habituated. We have observed cue-reduction in perception, and the elimination of dispensable movements in the development of motor skills. In conditioning we noted that the organism soon gets on without the unconditioned stimulus. The meanings of a wide range of experiences become condensed into a single concept. The organism seems to be ever striving to reach its goals in the most direct manner and with the greatest possible economy of time and effort.

Under repeated contacts with an object or person recognition follows such a course of reduction. A thing may be so familiar that it is directly apprehended as that known thing. One's own hat, for example, is ordinarily perceived directly as his hat. But if a person's hat becomes mixed with a dozen others, in picking it out he probably would resort to recognition. The teacher in the classroom directly apprehends the children as her pupils. Repeated daily contact with them dispenses with recognition as such; but on the street she may recognize a child as one of her pupils. The tools with which one works every day are known but not recognized. They may be picked up in the course of habituated action even without clear perception. Thus, the recognitive consciousness declines under repetition and the adjustments, which at an earlier stage of acquaintance were made by way of recognition, come to be managed by direct apprehension, and eventually by neuromuscular sets or habits.

Is recognition easier than recall? It is often possible to recognize a name, a face, or an object when the memory trace is too weak for recall. Students usually feel that a recognition test is easier than a recall test, and this seems to be borne out by objective evidence. The method of recognition testing has already been described. Where retention is tested by both recognition and recall, the scores usually run higher for recognition. For example, in a laboratory exercise ten subjects were shown a group of twelve photographs with a name attached to each. Ten seconds were allowed for each picture. Then the pictures without the names were presented again, mixed with thirteen new ones. The subjects were asked to pick out the pictures which were first presented and to recall the name for each one. The mean results were: faces correctly recognized, 10.2; names recalled, 2.7. After allowing for the factor of guessing in the recognition scores by subtracting the number of errors from the number of correct responses, we still have a considerable advantage in favor of recognition over recall. Controlled experiments with larger groups of subjects and with other materials have generally shown much higher scores for recognition than for recall (1, 25). It has been found, however, that the difference depends to some extent on the conditions of the recognition test. This test can be made very difficult by using for the new items of the test series materials highly similar to those presented for learning.

Memorial recognition. When an object of memory is definitely placed as the particular one previously experienced, as in remembering the man who repaired the refrigerator yesterday, the deer that you saw near your camp, or the boy who threw stones at the junk dealer's horse, recognition is coupled with recall. There is the meaning that the remembered object is known. It has the quality of familiarity that characterizes the recognized object of perception. This is likely to appear in the recall of items learned by repetitions. However, recognition here lapses under repetition, as it does in the case of perception. In the automatic recital of verbatim materials recognition is by-passed.

SOME SPECIAL PROBLEMS OF MEMORY

Defects of Memory

Forgetting, as we have been considering it, is a perfectly normal process; but there are abnormal losses of memory and conditions under which an individual is unable to recall events which normally would be recalled. The general term for abnormal losses of memory is *amnesia.* Several forms of amnesia have been distinguished. These and other defects of memory appear as: first, defects of learning; second, defects of retention; third, defects of recall; and fourth, defects of recognition.

Defects of learning. Defects of this group are marked by an inability to learn anything new. They are associated with senility, arteriosclerotic and toxic conditions, and sometimes they are connected with head injuries. Having been told and asked to repeat simple things, such as the doctor's name or the time of day, the patient is unable to repeat them again after a few minutes. An old lady who was a patient in a psychopathic hospital was asked what she had been doing during the morning of that particular day. She stated that she had prepared her husband's breakfast, washed the dishes, fed the chickens, and done other chores about the home. Actually she had been a patient in the hospital for three months. She had no memory for the events of that particular morning. Her inability to remember the recent events is an example of defects of learning. In her replies we have an example of another feature of memory frequently observed in old age, and that is the tendency of old memories to persist when new ones can no longer be established.

Defects of retention. Diseases of the brain or brain injuries sometimes destroy the neural bases for memory. In such a case there may be a total or partial loss of memory. For example, in general paresis, a psychosis caused by syphilis, there is a progressive deterioration of the brain. At first the memory for recent happenings is impaired, but as the disease progresses the patient may suffer loss of all memory for his entire past.

In some cases through accident or sickness a person loses all memory for events of a limited period. There are also cases in which the amnesia is for a short period prior to an injury to the brain. It is thought that this may be due to the prevention by the injury of the consolidation of the impressions. This particular defect is accordingly known as *retroactive amnesia.*

In defects of retention the brain traces are wiped out or damaged. These are, therefore, *organic* defects, and there can be no restoration of the lost memory. Recall of the events for the period concerned cannot be made in dreams or in hypnosis, nor can the memories be recovered by psychoanalytic procedures.

Defects of recall. In this division fall those cases of inability to recall due, not to the destruction of the brain traces, but to some condition that prevents them from functioning normally. That the neural trends for recall are still present is indicated by the fact that the events sometimes are rehearsed in the patient's dreams, or recalled in hypnotic states. These defects are *functional* forms of amnesia. They are sometimes *general,* in which case the patient is unable to remember anything of his past life. He may be found wandering about not knowing his name, where he came from, or how he got where he happens to be. Sometimes there is inability to recall the events belonging only to a certain period of time. This defect of memory is called *localized* amnesia. There are other cases, known as *systematic* amnesia, in which the loss of memory is restricted to objects and events belonging to a particular group or class. Since in these forms of amnesia the retention has not been impaired, the patient may recover his memory under appropriate treatment and sometimes recovery occurs suddenly as a result of some experience that serves to break up the inhibitions which have blocked recall.

Defects of recognition. *Failure to recognize.* Deviations from the normal process of recognition appear in several forms. Three of the more distinct types are mentioned here. First, there are cases in which a person fails to recognize objects and places which under normal conditions would be familiar to him. This may occur in nervous disorders, such as hysteria, or under conditions of great fatigue.

False recognition. A second form of defect of recognition is the false recognition of strange places or persons. Many persons have had the experience of being in a place for the first time and having it seem so familiar that they feel as though they had actually been there or looked upon that scene before. This is called *paramnesia,* although the term is sometimes applied to all of the defects of recognition. It is believed to be due to elements in the new situation which are similar to elements in situations previously encountered, and possibly also to fatigue or emotional disturbance which dulls the individual's sensitivity to the new and strange elements.

False memories. Imagination is sometimes transformed into what for the individual is a memory, though from the standpoint of objective fact it is a false memory. This comes about when the object of imagination is falsely recognized. The individual is convinced that he remembers actually having done or seen something he has only imagined. This probably occurs as a result of repetition and confusions with partially deteriorated memories. Repetition causes the idea of imagination to become familiar and thus paves the way for its false recognition.

Some persons tell "tall" stories so many times that they come to believe them. A student once told the writer that she "remembered" attending a wedding that took place before she was born. She was aware that it was a false memory and that it was based on hearing the account of the wedding repeated many times in her early childhood and on her own vivid imagination of the event. It is believed that many of the alleged memories for events of the first two years of life are false. Reports by adults of their early memories have been found to be a very unreliable means of investigating the memory of children. It may be noted that in imagination the object is apprehended as supposed; but the supposition may have a backward temporal reference as does retrospective memory. The step from imagination to memory, therefore, is a short one. It may easily be taken by way of repetition, which breeds familiarity and leads to false recognition of the imagined object or event.

The Range and Accuracy of Report

The methods used in exploring the psychology of report were described in the section on methods of measuring memory. The usual procedure is to present to the subject a picture of some fairly complex situation or a collection of objects. Sometimes the subject witnesses a more or less dramatic incident, and then he is called upon to relate fully what he observed.

The range and accuracy of the report are influenced by several factors. In the first place, in order to get a full and reliable report, the individual's observation must be thorough and accurate. His perception of the scene or incident may be defective because of failure to attend adequately, or because of emotional excitement or an indifferent attitude. His report may be erroneous because of his poor judgments with respect to spatial and temporal relations; it may be incomplete because of forgetting; and it may be distorted by what the individual hears or sees between the incident and his report. Its accuracy and completeness are, moreover, influenced by the form of the report and by the character of the questions the individual is called upon to answer, and also by the factors of age and training.

Form of report. The report may be made in *narrative* form, in which the individual lists all the objects he can remember, or recounts, without prompting and in as full detail as possible, the story of what he saw. A second form of report is the *interrogatory* type. Here the individual is asked a series of questions, or is presented with a list of questions about the scene or incident. The narrative form is usually more reliable than reports given by answering questions. On the other hand, the interrogatory form is suited to bring out more details. The range is usually greater for the interrogatory report because of the prompting value of the questions, but this form of report is less reliable than the narrative because of the misleading suggestions often contained in the questions (22).

Greater accuracy is found for sworn testimony than for unsworn, and for items of which the individual feels certain than for those of which he is not sure. It has been demonstrated that the degree of certainty is greater for items included in a narrative report, and subjects have shown a willingness to swear to more items reported in this way than in the case of the interrogatory form.

The following data from a demonstration experiment will serve to illustrate these points; they are based on results obtained from thirty-nine students. A picture of an accident was projected on a screen for two minutes. The subjects were told to study it carefully as they would be called upon to make a full report on their observations. After the picture was removed they wrote first a narrative report, and then they were given a list of sixty questions about the scene of the accident. The results in part, stated in terms of averages for the thirty-nine subjects, were as follows:

	Narrative Report	*Interrogatory Report*
Range: per cent reported of total possible items	49	63
Accuracy: per cent of reported items that was correct	88	72
Certainty: per cent of reported items of which subjects were certain	84	56
Reliability of certainty: per cent correct of items marked certain	92	80
Oath: per cent of reported items to which subjects were willing to swear	56	40
Reliability of oath: per cent of sworn statements that was correct	92	89

With the lapse of time there is a decrease in both the reliability of the report and in the amount reported; but for both the narrative and the interrogatory reports the decrease is more rapid for accuracy than for amount (27).

Form of the question. The manner in which the question is phrased may greatly influence the subject's response. Some years ago Muscio (77) made a systematic study of the relation of various types of questions to caution or uncertainty, suggestiveness, and reliability of the answer. Among other things he found that the use of the definite article *the* in place of the indefinite *a* tends to make the individual less cautious, and the answer less reliable. The use of the negative *not* gives a question greater suggestiveness, and decreases caution and reliability. Example: "Didn't you see a dog?" A question that simply asks whether certain things happened, or were present, is conducive to less caution in answering and to less reliability of the answer than one that asks the individual whether he saw or heard them. Of all the forms of questions studied the implicative type, such as "Was the dog black?" which implies that there was a dog, was found to be least conducive to caution and reliability. A question that asks for one of two possibilities where there may be more, such as "Was the dog black or white?" is called *incomplete disjunctive.* It is, compared with other forms, high in suggestiveness and low in caution and reliability. This investigator concluded that for the most reliable answer the question should not contain the definite article or the negative, and that it should be specifically directed toward what the individual actually observed.

Age differences. Children are inferior to adults in both range and reliability of reports on what they have seen and heard. This is due to the child's more limited experience, immature judgment, imperfect understanding, and greater suggestibility. As he grows older the range of his report increases faster than its accuracy. The reports of very young children in picture tests are usually mere enumerations of objects. Later the ability to describe in terms of relationships develops, and at the age of ten or twelve, children are usually able to evaluate and interpret. Through adolescence there is growth in the ability to analyze and organize experiences (110, 111).

Improvement through training. The reliability of report may be increased by means of practice. One investigator had his subjects report on three different pictures. The second was shown a week after the first, and the third a week after the second. Both narrative and interrogatory reports were made. Improvement resulting from practice was shown by the fact that the second report was more accurate than the first, and the third was more accurate than the second. In the later tests the subjects showed greater ability to resist the influence of suggestive questions in the interrogatory reports. Educated subjects improved more under practice and were less willing to take oath to answers to suggestive questions than the uneducated (9).

The training of children for accuracy in reporting should be suited to their developmental level, and it involves both instruction in observation and practice in making reports. In training the child to observe more effectively an adequate motive or interest must be secured. Attention should be directed to important features and essential details of the situation. Questions that stimulate discovery by the child are useful and effective for this purpose. In report training the child's attention should be called to his errors or misstatements. Children usually are uncritical of their statements and often make incorrect ones with a high degree of assurance. They are prone to fill in the gaps in their memory by their own imagination. Young children often confuse the product of their imagination with the objects of perception. They are easily influenced by suggestion. They need to be taught to be more critical of their reports, to distinguish fact from fancy, by the teacher's refusal to accept erroneous statements and by having pointed out to them the discrepancies between their reports and the facts presented for observation. In the interest of accuracy of statement they should be taught that it is better to admit that they do not know than to guess.

Memory Training

In psychology today we do not regard the memory as a faculty of the mind that may be made a more effective rememberer by exercise. Memory is a broad term that stands for certain types of activity carried on by the individual. The individual may be trained so that he can learn, retain, and reproduce more efficiently; and this is what we mean by memory training. The fundamental capacity to receive, retain, and reproduce is limited by the quality of the brain we inherit. We do not increase this inherited capacity by training, but we may improve our memory by learning to use more effectively this gift of nature.

The improvement of memory will be accomplished almost entirely by improving our methods and habits of learning. We cannot do much of anything to improve retention, apart from improvement of learning, except to avoid more consistently the activities which may produce retroactive inhibition. There is not much to be done to improve recall itself, except the adoption of practices which enable us to avoid the deleterious effects of fatigue and emotional disturbances, and the acquirement of greater cleverness in utilizing accessory stimuli as means of arousing recall. But retention, recall, and recognition will all be greatly improved as learning improves. The use of our memory facilities is somewhat like our use of a trunk. The capacity of the trunk is fixed by the manufacturer; but the amount of clothing and other material we may carry in the trunk depends upon how systematically we pack it. The capacity of the brain to receive and retain is established by nature, but how much the brain will carry depends upon how effectively we use it.

Summary of the Chapter

This chapter is concerned with the persistence and efficacy of the functional tendencies established by learning. The principal topics are: retention, recall, and recognition.

Retention, it is believed, is best explained in terms of impressions or traces left in the nervous system by the learning activity. Forgetting is due to loss or deterioration of these impressions.

The principal methods for measuring learning and retention are: first, memory span; second, retained members; third, recall; fourth, recognition; fifth, paired associates; sixth, anticipation and prompting; seventh, complete mastery; eighth, relearning; ninth, reconstruction; and tenth, report.

The typical curve of retention for both meaningful and nonsense material shows negative acceleration. The rate of forgetting is most rapid soon after learning. The rate of forgetting and amount retained are influenced by the meaningfulness of the material, the degree of learning, the distribution of practice, the set of the learner, and the amount learned. Fast learners generally retain better than slow learners. Affectively toned material is remembered better than indifferent material, and it appears that we remember pleasant experiences better than unpleasant. We forget very little during sleep. This fact suggests that forgetting is due to activities which follow learning.

Retroactive inhibition is the impairment of retention caused by activity which follows learning. The amount of retroactive inhibition varies with the degree to which the interpolated activity resembles the original learning, the degree of learning, the age and intelligence of the learner, age of the associations, and the temporal position of the interpolated activity within the interval.

The increase in retention scores during the interval following learning is called *reminiscence*. The amount of reminiscence varies with the method of learning, position of items within the series, and the character of the learned material. It is probably due to the disappearance of factors that interfere with recall.

Qualitative changes which occur during the interval include: the insertion of new elements, transpositions, distortions, substitutions, and omissions. Studies of forgetting of school subjects usually show a big loss after an interval, and the rate of forgetting is usually negatively accelerated. The amount lost after a given period varies for different subjects. In some cases a child makes a better test score after the summer vacation than at the end of the school year. This is probably due to practice and incidental learning during the vacation. Factual information is forgotten faster than the ability to apply principles. Tests given soon after learning have been found to aid retention. For purposes of review after a relatively long period, rereading appears to be superior to a test. Suggestions are given for procedures for securing good retention.

When methods and degrees of learning are about the same, there appears to be little or no difference in persistence between motor skills and verbal learning.

Recall is a renewal of a function which runs its course without the aid of certain sensory stimuli upon which it originally depended. The conditions of recall include: a means of arousal, neural trend, set, emotional states, and reproductive inhibition.

The essential feature of recognition is the meaning that the object perceived or recalled is known. Recognition frequently, but not always, is mediated by the recall of something previously connected with the object of recognition. It is usually easier than recall, appears in various degrees of definiteness, and tends to lapse as a result of frequent repetition.

The defects of memory include: the inability to establish new memory patterns in the nervous system, loss of the neural impressions through injury or disease, inability to recall because of inhibitions, failure to recognize, false recognition, and false memories.

The range and accuracy of report depend upon the effectiveness of the observation, the length of the interval, hearsay, judgment, the form of report, and the character of the questions. Two forms of report, narrative and interrogatory, are discussed. Children are inferior to adults in both range and accuracy. The quality of the report may be improved by training.

The improvement of memory is mainly a matter of improving the manner of learning.

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CHAPTER XIX

TRANSFER OF TRAINING

The meaning of transfer. When training in one situation on one form of activity affects one's ability in other types of activity or one's performance in different situations we have what is commonly understood as *transfer of training*. Common experience affords abundant evidence of such transfer. Having learned to drive one car, we drive another for the first time almost as well. We use our old driving habits in the new situation. Our familiarity with the subways of Boston enables us to use the subways of New York for the first time with greater ease and confidence than would be possible with no previous subway experiences. Daily we use our ability to read and write in reading new material and in writing what we have never written before. When the child's learning to multiply is facilitated by his previous mastery of the addition facts, he is transferring his training in addition to multiplication. When the study of history aids the understanding of current political problems, we have transfer.

In countless ways, we use the results of past learning in new ways and in meeting the demands of new situations. All applications of knowledge in the understanding and solution of new problems, and the use of old habits in dealing with new situations are cases of transfer of training.

From the standpoint of education the problem of transfer centers principally on two points: first, the extent to which the learning of one thing facilitates the learning of something else; and second, the extent to which learning in classroom situations carries over to life situations outside the classroom.

The significance of the problem of transfer. The extent to which training spreads or carries over to new situations, to new problems, and to other activities and the conditions under which such transfer takes place are matters of prime importance to educational theory and practice. Such momentous issues as what subjects shall make up the content of the curriculum and the aims and methods of instruction are inevitably decided according to the views, convictions, and prejudices held by the leaders of educational thought in regard to this problem.

In the past, differences in views concerning the spread of training have occasioned heated controversies among educators on such questions as whether the material learned or the process of learning it is the more important consideration, whether a mastery of the ancient classical languages is essential to a liberal education, and whether the chief function of education is to sharpen the intellect in general or train specifically for future activities.

History reveals not only these controversies, but also the practical consequences of the prevailing attitudes. There is probably no question concerning learning which has occupied the thoughts of educational philosophers and in turn affected the actual course of educational history more than that of its transfer or applicability to lines of endeavor beyond the limits of the sphere of actual training.

Formal discipline. The modern scientific investigations of the problem of transfer of training are set against a background of several centuries of rationalistic inquiry concerning the mind and its training. Conspicuous in this background is the doctrine of formal discipline. This doctrine was based upon a psychology which is not accepted by reputable psychologists of today. This psychology is known as *faculty psychology*. It held that the mind is composed of a set of faculties or mental powers, such as: the will, memory, attention, judgment, observation, reason, and the like.

It was believed by educational theorists that the chief concern of education was to develop and strengthen these faculties. They reasoned, furthermore, that it was the process of learning that mattered most, not what was acquired in the way of information or skills to be used. The mental faculties were believed subject to improvement, strengthening, or enlargement by exercise, much as a muscle is strengthened by use. For this reason subjects were included or retained in the curriculum, not because they contributed usable information, but for their supposed value as instruments for sharpening the intellect and toughening the fibers of the mind.

The outstanding example of the consequences of this doctrine is seen in the dominant place held by the ancient languages in education. Latin, which had dominated the schools of the Middle Ages and of the Renaissance, had by the end of the seventeenth century lost its exalted position as the language of the clergy, diplomacy, the universities, and writers because of the emergence and adoption of the vernacular languages in these areas. Having ceased to be the exclusive language of culture and the humanities, its place in the curriculum was made secure by the argument that no other subject, except possibly formal mathematics, could equal it as an instrument of mental discipline. This view was supported by educational tradition and conservatism.

Now according to this conception of mental training it was supposed that the intellect or the faculties of the mind were strengthened by appropriate discipline and in that way the individual was best prepared for all of the demands of life. We therefore have the notion of a sort of blanket transfer of training from one kind of learning to any situation or activity no matter how different and remote. The study of the classics and formal mathematics was regarded as a means of generating mental power, and this reservoir of power could be drawn upon to cope with any situation. Here was a theory of transfer most sweeping in its claims, based on rationalistic speculation, not on scientific evidence.

This doctrine dominated education from the sixteenth century well through the nineteenth despite the protests of certain notable scholars. If the discipline of the mind was to be the chief aim of education, then effort should be centered on the subjects most suited to accomplish this. There was no need for varied offerings to meet individual needs. In the Latin grammar schools little was taught beyond Latin, Greek, and mathematics. In the colleges the classical curriculum was commonly regarded as the only one that afforded real education. Until very recently, to gain entrance to these higher institutions, the student must have devoted about one fourth of his time in high school or academy to the study of Latin.

In the elementary school, arithmetic was full of useless material selected for its supposed value for training the mind. The process of weeding this out has been occupying the attention of educators only in very recent years. Spelling included the memorizing of thousands of words the child would never use in his own writing. Much attention was given to formal grammar, not to promote good English usage, but to discipline the mind. Methods of teaching were strict and in conformity with the view that not what the child learned but the discipline he received in the process was the important consideration.

An incident, which occurred in an American academy in the 1870's, will serve to illustrate the operation in the classroom of this conception of education. The instructor had required the memorization of a list of all the states and their capitals and an examination question called for the reproduction of the list. One boy gave the name of every state and its capital correctly, but his answer was marked zero. When he asked his teacher why he had received zero for his answer, she pointed to one of the words and exclaimed, "Why look! You left the final *e* off the State of Maine!"

While the doctrine of formal discipline has been discredited by modern scientific research and is not accepted by psychologists and most educators today, it is still reflected in the public utterances of some educators and in the practices of some teachers. Recently a professor of English in an institute of technology who felt that the students tended to attach more importance to their "practical" subjects than to the academic or cultural subjects, stated in behalf of the latter in an address before a body of students that he believed in "good old mental muscle" and maintained that it could be strengthened by such studies. Unfortunately, there are still some teachers who require their pupils to memorize lists and tables of factual items which have no immediate or future value for the pupils, with a vague notion that somehow the arduous labor of memorizing will itself improve in some way the mental caliber of the victims of such practices.

The "Committee of Ten." The situation in the last decade of the nineteenth century is reflected in the report of the "Committee of Ten" of the National Education Association (33). This committee was appointed in 1892 to make a survey of prevailing practices with regard to the secondary-school studies and to make recommendations and suggestions for improvement in such matters as methods of teaching, time allotment, programs of study, examinations, and college entrance requirements. The committee organized nine conferences of experts in the various subjects taught in the secondary schools. The general tone of the reports of these conferences and the recommendations of the committee were in favor of mental training. The report of the conference on history, for example, contains the following statements regarding "training of the mind."

> The principal end of all education is training. In this respect history has a value different from, but in no way inferior to, that of languages, mathematics, and science. The mind is chiefly developed in three ways: by cultivating the powers of discriminating observation; by strengthening the logical faculty of following an argument from point to point; and by improving the process of comparison, that is, judgment.
>
> As studies in language and in the Natural Sciences are best adapted to cultivate the habits of observation; as mathematics are the traditional training of the reasoning faculties; so history and its allied branches are better adapted than any other studies to promote the invaluable mental power which we call the judgment. (33*a*)

The majority report of the Committee of Ten supported the doctrine that it made no difference in a student's future what subjects he studied so long as they provided "strong and effective mental training" (33*b*). A voice of protest against this view, however, was raised in the minority report of the committee which called attention to the importance of considering "the nature and value of the content" of the subjects taught (33*c*). This minority report is significant in that it portended changes to come.

Early experimental investigations of the problem of transfer. About this time laboratories of psychology were being established in American universities and the practice of investigating psychological problems by experimentation was increasing. Experimental evidence promised a sounder solution to the problem of mental training than arguments based on logical considerations, educational tradition, and prejudice.

The first attempt to test experimentally the claims of the disciplinarians was made by William James, psychologist at Harvard (26). He undertook to discover whether practice in memorizing lines of poetry of one author would produce a general increase in ability to memorize. He first measured his ability to memorize by finding the time required for learning 158 lines from Victor Hugo's *Satyr*. Then he practiced memorizing for about twenty minutes each day for thirty-eight days. During this training period he committed to memory the entire first book of Milton's *Paradise Lost*. He then returned to the *Satyr,* selected another 158 lines, and memorized them. He found that it took him longer to learn the second selection from the *Satyr* after this period of intensive training than to learn the equivalent selection before training. Because he was somewhat "fagged" by other work at the time he learned the second selection, he induced four other persons to make a similar test. Of these, three showed slightly reduced times for learning after training; for the fourth there was a slight increase. James believed that there was no improvement of the power of retention because of the practice, and that any improvement of memory was a matter of acquiring more proficient methods of learning. This experiment lacked sufficient controls to be conclusive, yet the position taken by James on this question was definitely against the efficacy of formal discipline as a means of improving the memory.

From about 1900 on, many scores of experiments by other psychologists were made with more refined methods in a search for reliable evidence regarding the amount and conditions of the transfer of training. These experiments have dealt with a wide variety of materials and various types of learning. Of outstanding importance among the earlier studies were a series of experiments by Thorndike and

Woodworth in the field of observation and judgment (46). In one of these the subjects were trained in the estimation of areas of rectangles ranging in size from ten to 100 square centimeters. Considerable improvement in this function was secured by informing the subject of the true area after each estimate. To discover whether this training would produce any improvement in the ability to judge areas other than those to which the training was applied, tests of ability to estimate areas of other shapes and sizes were given before and after the training. The results showed that the subjects did do better with the other areas after training. But this indirect improvement fell far short of the results for the areas on which training was given. The errors were much greater for larger rectangles and for areas of different shape but of same magnitude. Thus, there was definite evidence of transfer effects, but the transfer was small compared to the improvement in the practiced function. Similar results were obtained from experiments on judging lengths of lines, the estimation of weights, and the cancelling of various types of words from a printed page.

The transfer effects found in these experiments were attributed by these experimenters to the similarity of the materials upon which the subjects were trained and those used in the transfer tests, and to the fact that the subjects acquired by the training certain procedures that could be used to advantage in the after-tests. It appeared also that familiarity with the experimental task and a feeling of confidence developed during practice carried over to the final test with the other materials. The fact that such transfer as did occur could be accounted for in these ways, together with the fact that the transferred results of training were small in comparison with the improvement secured from direct training even in such closely related functions, was devastating evidence against the view that observation and judgment could be developed by exercise on one function and be equally proficient in performances differing from the one practiced. The findings were squarely against the doctrine of formal discipline as it had commonly been interpreted.

Procedures in experiments on transfer. In the earlier studies on transfer effects the usual procedure was first to test a group of subjects to determine their ability in some one type of performance. Then training was given these subjects in a different activity. Following training a second test was given in the performance originally measured but not trained. If the subjects did better in the final test than in the initial one, the improvement was assumed to be the transferred effects of the training received on the other activity between the tests. Such a procedure is subject to error because of the practice effects of taking the tests. A subject may be expected to do better in a second test in any activity because of the practice provided by the first test. All of the improvement, therefore, indicated by the final test cannot be attributed to the transfer effects of the intervening training.

Later experimenters overcame this difficulty by the use of a control group. Under this procedure two equivalent groups are first tested on one form of activity. Then the experimental group is given special practice or training on a second activity. The control group is not given this special training. Finally both groups are again tested to discover any increase in proficiency of the first activity. In computing the amount of transfer from the training to the performance in the final test, the gains of the control group are subtracted from the gains of the experimental group. The outline of this procedure is as follows:

Experimental Group:
  (1) Test I, Activity A; (2) Training, Activity B;
  (3) Test II, Activity A.
Control Group:
  (1) Test I, Activity A; No training on B; (2) Test II, Activity A.
Gains = Results of Test II minus results of Test I.
Transfer Effects = Gains of Experimental Group minus gains of Control Group.

The practice effects from taking a test, which enables one to do better in a second test, are in themselves a form of transfer from the first to the second test situation. This sometimes appears in experiments not aimed at the study of transfer. In such cases care must be taken to prevent it from becoming a source of error. For example, in a recent study, which sought to discover the relative effectiveness of two different forms of instruction in perceptive goal-searching, children were asked to find a certain object in a search field consisting of an array of eighty-five small objects. In one form, called *visual instruction,* each child was shown a duplicate of the object he was to find. In the other, called *verbal instruction,* only the class name of the search object was given, such as "Find a button." Each child was tested once with visual instruction and once with verbal instruction. It was recognized that familiarity with the field of search gained from the first test might make the second task with the other method of instruction easier if the same field were used again. Therefore, the second method was used with a second field. Practice effects were still in evidence, however, because the average time required to find the search object was shorter under both methods of instruction when they came second, than when they were first in the order of procedure (1).

A disadvantage of the method of studying transfer effects by giving a test in one activity before and after training in a different one lies in the fact that it is limited to one stage in the mastery of the performance tested. This will be the early stage of learning in those cases where the only practice on this performance is that offered by the first test. The rate of improvement for a given amount of practice varies at different stages of mastery, and the transfer effects might vanish after a few trials if practice on the test performance were continued until a higher degree of proficiency in it were attained. For these reasons many researchers have employed the method of "successive practice" in their studies of transfer. In its usual form two equated groups are used. One of these groups is given practice on activity A. Then both groups are given practice on activity B. If the former group makes better progress in activity B under the same conditions of practice, it is presumably because of that group's previous practice on activity A. Thus, transfer of training is seen in the influence of previous learning upon the ability to learn new materials or to acquire new skills. A number of variations of the method of successive practice have been employed.

Transfer in the motor functions. In the field of sensorimotor learning, practice with one bodily member or set of muscles may increase an individual's ability to achieve a similar result with other members or other neuromuscular mechanisms and with different movements. Human subjects (page 151) who had been conditioned to lift the right hand at the sound of a buzzer to avoid shock readily lifted the left hand at that signal instead of the right when the left was resting on the electrode. Rats trained to run a maze, readily swam it when it had been submerged in water (page 150).

Dogs paralyzed temporarily in the right hind leg by severing the motor nerves were given conditioning trials with buzzer and with shock on the right hind foot. The experimenters reported that when conditioning was established some of the operated animals lifted the paralyzed member at the sound of the buzzer to avoid shock by swaying the body to the left or by standing on the toes of the left foot. During training they learned to escape shock in this way without flexing the muscles of the right hind leg. As soon, however, as the severed nerves were regenerated, they substituted without further training the flexion of these muscles to accomplish the same result in a more normal manner (29).

In another study training of the right hand in hitting a target seen in a mirror transferred to hitting the target with the right foot to the extent that the equivalent of about six trials was saved (7). Transfer was also found to take place from practice with the right foot to the performance with the right hand, and to some extent from one hand to the other. The experimenter concluded that transfer in this experiment was achieved through acquired methods of procedure, which were useful when another member was employed, and through familiarity with the experimental situation. Thus, training, which acquaints the learner with the essential requirements for reaching a certain goal, may be transferred to the use of other neuromuscular mechanisms for reaching that goal.

Training that transfers to corresponding members of the opposite side of the body is called *cross education.* This bilateral transfer is seen, for example, in the improvement of performance with the left hand resulting from practice with the right hand. Several experiments have explored bilateral transfer. One of them by Munn (32) will illustrate the character of this work and the usual findings. The activity in this experiment called for eye-hand coördination. The apparatus used consisted of a wooden cup attached to a long handle and from the bottom of which was suspended, by means of a string, a wooden ball. The task was to grasp the handle and flip the ball into the cup. The subjects were 100 college students, fifty men and fifty women. There were two training groups of twenty-five students each, and two control groups of the same number. The training groups were given fifty trials with the left hand, then 500 practice trials with the right hand, and finally fifty additional trials with the left hand. The controls received no practice with the right hand. They were given fifty trials with the left hand, rested for forty-five to sixty minutes, and then they practiced for fifty more trials with the left hand. The average increase in facility with the left hand from the first fifty trials to the second fifty trials was 61.14 per cent for the experimental groups, and 28.5 per cent for the controls. Thus, a difference of 32.6 per cent was found in favor of the groups that practiced with the right hand, due, apparently, to the transfer effects of that practice to the use of the left hand. Comments of the subjects indicated that during practice with the right hand they discovered the kinds of moves which brought success, and they were able to profit by this knowledge when they came to the second set of trials with the left hand.

A number of experiments have shown transfer from the right to the left hand in mirror tracing and in other forms of sensorimotor learning (23). Positive transfer has also been found from the left hand to the right, from hands to feet, and from each foot to the other in the learning of an irregular maze pattern (17). In some experiments the advantage of previous practice with a different member appeared mostly in the early trials and diminished as practice was continued. This advantage appears to be due to an acquaintance with the problem, familiarity with the experimental situation, greater ease and confidence, and to a knowledge of procedures or movements best suited to accomplish the desired results. Having discovered during the previous practice ways and means for dealing with the situation, which apply equally well to the performance with another member, means that the second task is partially learned when practice on it is begun.

The advantage afforded by this knowledge factor is similar to the aid provided by instruction in best procedures and matters of form or by observing another person demonstrate correct procedure before beginning practice. As an example of how this works we may take the case of mirror tracing or hitting a target seen only by means of a mirror. In the first practice the subject discovers that if he is too far to the right, in order to correct his error he must move farther to the right and not to the left. This method of dealing with the mirror illusion is then readily applied to the practice with another member. It gives the subject a running start in the second practice series, which results in a saving of time and effort at least in the early stages of that practice.

Another experimenter studied transfer in motor learning by measuring the effect of learning one maze upon the learning of several others (48). He found in each case definite evidence of positive transfer effects. However, the amount of transfer varied widely, from twenty to seventy-seven per cent, as measured by trials for the different mazes. One of the mazes used in the transfer series was similar to the maze previously learned except for a section of it which was made a blind alley. To master this maze the subjects had to break the previously acquired habit of turning into this section. There was considerable interference from the previous practice in the mastery of this part, for the subjects who had learned the otherwise similar maze had greater difficulty in eliminating this section than did controls who had not learned that maze. For this maze as a whole, however, there was positive transfer. It appeared that the transfer effect was the net result of both facilitation and interference. Moreover, as was pointed out in the report, the wide variation in the amount of transfer for the different mazes strongly indicates that the amount of transfer from any learning depends upon the nature of the task to which the shift is made.

Negative transfer. It sometimes happens that previous learning retards the learning of a new performance. In cases of this kind the interference is greater than the positive carry-over and the result is called *negative transfer.* This has been demonstrated, for example, in card-sorting experiments in which the subject practices the sorting of cards into compartments numbered to correspond to the cards. After considerable facility has been acquired, the order of the compartments is changed and the subject is asked to place the cards according to the new arrangement. In performing the second task the previously formed habits tend to carry the hand in the direction of the former positions of the compartments. This interferes with the making of the proper movements and retards the second learning.

Negative transfer effects have been found by several experimenters. Recently in a mirror-tracing experiment Cook (18) found in the error data evidence of marked negative transfer from practice with the mirror in one position to tracing with the mirror in another position.

If one is to master two such interfering sets of habits as those mentioned above, it has been shown experimentally that the most economical procedure is to master one thoroughly before starting practice on the second. Pyle (36) describes an experiment in which a group of subjects sorted cards with one arrangement of boxes an hour a day for fifteen days, and then switched to practice with a different arrangement of boxes for an additional fifteen days. Another group practiced the two arrangements for thirty days but practiced each arrangement on alternate days throughout the whole period. Better results were obtained from the first procedure. Pyle points out by way of application of this principle that it is not advisable to attempt to learn two different systems of writing or two foreign languages at the same time.

Memory training. The results of the pioneer study of James on memory practice prompted a number of studies of transfer in the field of memory. In an early experiment by Ebert and Meuman (22) practice in memorizing nonsense syllables was found to improve rapidly the ability to memorize other lists of this kind of material. These authors believed the improvement was due to acquiring better methods of memorizing, the discovery of helpful devices (such as rhythmical grouping), increased confidence, the reduction of anxiety, and adjustment to the experimental situation. Tests given before and after this practice indicated on the whole a rather large amount of improvement (about fifty-two per cent) in the memorizing of prose, poetry, disconnected words, letters, numbers, visual forms, and Italian equivalents of German words. All of this improvement was attributed to transfer.

However, no control group was used, and there was evidence of a great amount of practice in the test series. When later a check was made to determine how much improvement was due to practice in taking the tests, the amount found attributable to actual transfer was greatly reduced (21).

Fracker (24) used a control group in a study of the effects of practice in memorizing the order of four tones of the same pitch but of different intensities on the ability to memorize other material. For the most similar test performances, such as memorizing the order of four grays, and the order of nine tones, the improvement of the practice group was sixteen per cent greater than for the controls. For less similar tasks, such as memorizing poetry and geometrical figures, its improvement was less than four per cent greater than that of the control group.

One of the most thorough investigations in the field of memory was conducted by Sleight (40). He used a control group and three practice groups equated on the basis of several memory tasks. There were two series of experiments: one with school children, another with college students as subjects. The materials of the test series were dates, nonsense syllables, poetry, prose, and letters. All groups were tested before and after the special memory practice. Between tests one group memorized poetry, another learned "tables," and the third practiced reproducing prose substance. The control group received no memory practice between tests. The results were varied and conflicting. In some tests there were gains for the practice group only to be offset by losses in others. In several cases the controls gained more in the test performances than the practice groups. There was no indication that the extensive practice had produced any general improvement in memory, nor was there any evidence to support the belief in a general memory function. The results suggested that the term *memory* covers many functions both related and unrelated.

The experiments mentioned above and others reported in the older literature seemed to agree in showing that memory as a whole was not uniformly improved by practice on one kind of material or on one type of memory task. They indicated that *sometimes* there was positive transfer and that at other times the transfer effect was negative or approximately zero. They also showed rather definitely that the greatest transfer occurs in cases where the trained and tested activities were highly similar. For example, practice in memorizing nonsense syllables increased the ability to memorize other lists of such syllables, but resulted in no significant improvement with prose selections or other dissimilar materials. It therefore appeared that the amount of transfer varies with different conditions, and the aim of many of the more recent studies has been to discover more specifically the conditions favorable to the maximum amount of transfer.

It had been noted that improvement by transfer had frequently appeared as the result of acquiring better procedures. During the practice series the subjects apparently learned how to learn. Of special significance, therefore, is an experiment by Woodrow (52) in which practice with instruction in effective methods of memorizing was compared with practice without such instruction. Three groups of student subjects were employed. Tests in memorizing were first given to all three groups. Then over a period of four weeks two groups practiced memorizing nonsense syllables and poetry, one with instruction regarding effective methods of learning and the other without such instruction. The control group received no practice during this time. All three groups were tested again after the practice period. The group that practiced without direction showed very little transference to the final tests and this was sometimes negative. The control group did about as well. On the other hand, the group that was instructed in methods which other learners had found helpful, such as self-testing, making meaningful associations, use of rhythmical grouping, and learning by the whole method, was definitely superior to the other two groups in the final tests. These results give definite support to the belief that transfer may be secured through improved methods of learning, and they showed also that without direction routine practice is likely to have little or no transfer value.

Problem-solving functions. The conditions under which practice in solving one kind of problem may help or hinder one's solution of other problems were explored by Ruger (38) in an experiment with mechanical puzzles. He found definite transfer from practice in taking a puzzle apart to putting it together. In one case a subject took a puzzle apart 400 times without putting it together or seeing it put together. He then put it together five times. His average time for putting the puzzle together was just one tenth the average time for the first five trials in taking it apart. Since the movements involved were reversed Ruger believed that the transfer was not due to the carry-over of motor habits but to an understanding of the construction of the puzzle acquired during practice in taking it apart.

Different positions of the puzzles required different initial manipulation. Positive transfer from one position to another was found when the subject clearly saw by analysis what adjustments were needed to use the practiced habits in the new position. But when such insight into the process required for solution was lacking, the old habits produced interference when the puzzle was changed to a new position. Practice with one puzzle transferred positively to the solution of another puzzle involving similar procedures, when the subject discovered by analysis during practice the underlying principle and devised a formula for solution that was appropriate for the new puzzle. Motor habits, carried over without the benefit of analysis and generalization of procedure, led to error and negative transfer effects when they were inappropriate and to positive effects when they happened to be appropriate. Among the factors promoting transfer in puzzle solving listed by Ruger are: heightened attention on the task, shift from self-consciousness to a problem attitude, improved methods of attack, analysis and generalization of procedure, and an awareness of the similarity of the new case to the old.

A number of studies have been focused on the functions of comprehending and the solving of problems by thinking. Winch (51) used school pupils as subjects in a study to determine whether training in solving one type of problem would improve the ability to solve other kinds of problems. Initial and end tests were given in logical reasoning. In the period between the tests the control group worked on their usual lessons while the training group received practice in solving arithmetical problems with special attention to the principles involved. The end tests showed that the practice group improved significantly more in logical reasoning than the controls.

Barlow (4) found that special training in analysis, abstraction, and generalization transferred positively to test performance that consisted of giving the lesson or moral conveyed by various fables. These and other studies indicate the possibilities of positive transfer of practice in problem solving with one kind of material to reasoning in other types of problems. They indicate also that this transfer is achieved by acquiring an understanding of principles; by developing confident, analytical, searching attitudes; and by learning effective procedures.

A general view of the experimental evidence. The earlier studies on this problem were primarily aimed at discovering whether training in one activity improves ability in some other form of activity and the extent to which such training transfers to the new performance. Experiments have been made with various sorts of materials on various aspects of action, perception, memory, and problem solving. Investigators have employed animals, children, and adults as experimental subjects.

The findings have varied widely from a large amount of transfer effects, through little or none, to an actual loss, or negative transfer. They have served to establish beyond a doubt that transfer does take place, that training in one activity does *under certain conditions* affect ability in activity other than that specifically trained. They have clearly shown that in general the improvement from transfer is small or negligible unless the new activity or situation is highly similar to that in which training was given. The transfer effects are usually much less than the results of direct training. When one shifts to an activity different from the one in which he was trained, there is always a loss in proficiency. It seems clear, therefore, that for the maximum benefit from practice one should practice directly on the performance in which proficiency is desired.

The variations in the amount of transfer effects under different conditions give no support to the traditional view that there are mental faculties or powers which can be strengthened by exercise in one activity and thereby become more capable agents for meeting all demands made upon them regardless of the nature of the activity required. More in accord with the evidence from transfer experiments is the view that we are confronted in the analysis of this problem, not with a set of mental agents, but with manifold forms of functioning of a complex organism. These forms of functioning may be grouped according to resemblances of mode under such general classificatory terms as *perceiving, remembering, problem solving, acting,* and *comprehending*. It appears that training in one function may or may not improve performance in another. Whether it does and to what extent depends upon a number of conditions.

The earlier experiments in this field revealed some of the conditions which seemed to favor or restrict transfer. More recent studies have brought to light a wealth of detailed information on this aspect of the problem. Some of these we shall consider as we inquire more fully into the conditions affecting transfer. A number of these studies, while pertinent to a thorough analysis of the problem of transfer, are concerned with details too far removed from educational practices to warrant a discussion of them in this account.

A review of the studies made on this problem will bring the critical reader to the realization that the difference between the activity directly trained and the activity to which the transfer is made varies greatly. A clear-cut logical distinction between these activities is difficult to make. Just how different must a situation or task be to fall within the common conception of transfer? Probably no total situation ever recurs in identical form, and in a strict sense every psychological function is determined to some extent by others that have preceded it. There is probably no acquisition by learning which is wholly free from the influence of previous learning except for the most primitive modifications of innate activity. There is in a sense transfer from one trial to the next in any instance of practice. The from-what-to-what in the problem of transfer presents all degrees of differences, from those which are so slight as to lead to the common acceptance of the new as the same as the old, to those which are as great as that found between drill on Latin vocabulary and building bridges.

Some of the transfer experiments have dealt with highly similar performances, such as the effect of training in judging the area of rectangles of one magnitude on the ability to judge the area of rectangles of larger magnitude, or the transfer effects of practice in memorizing nonsense syllables on the speed of memorizing other lists of nonsense syllables. It seems to be well established that with other factors constant the amount of transfer varies directly with the degree of similarity between the trained activity and the transfer activity. A striking feature of the results of many experiments is the smallness of the transfer effects under even small differences between the two situations or activities. It is to be noted also that common features of the training and test situations sometimes produce interference or negative effects.

Conditions of Transfer

Common components. Since the time of the earliest experiments it has been recognized that the more the two performances involved have in common the more will training in the first tend to improve the second. The important experiments by Thorndike and Woodworth (1901) described above led to the formulation by Thorndike (41*a*) of the famous and broadly accepted doctrine of *identical elements*. There might be identical elements in the content of subject matter learned, in attitudes, or in methods of procedure. Thus, training in the process of addition would transfer to learning multiplication because in multiplication the pupil uses many addition facts. The procedure in adding involved in multiplying is the same as that involved in solving problems of addition. Names and dates learned in studying American history may aid in the study of American literature where topics in the two subjects relate to the same period (identical elements of content). A searching, alert attitude developed in solving one set of puzzles may accelerate the solving of a second set, or self-confidence from success in one subject may promote achievement in another (identical elements of set). Thorndike (41*b*) maintained that improvement in one function serves to alter another "only in so far as the two functions have as factors identical elements." But since transfer sometimes appears when it is not possible to identify the elements common to both, he stated (41*c*) that, "By identical elements are meant mental processes which have the same cell action in the brain as their physical correlate." Thus, the explanation of transfer in terms of identical elements, to make it elastic enough to cover all cases, was extended to the realm of neurological hypothesis.

Because the term *element,* as commonly used, refers to an unanalyzable or at least very simple constituent of a whole and because transfer may result from a common functional trend or common part-functions in themselves not simple, Woodworth (1938) suggests that it would be more appropriate to use the word "constituent," or "component" in the place of "element" (53). When two functions have common components, the training of one is likely to effect a change in the other, though this change may be either positive or negative according to other conditions including the amount of practice.

Since there are several aspects and phases of a function, it follows that identity, partial identity, or similarity of two functions may occur in the motives, controls, initial phase (stimulus factors), steps in progress toward the goal, or end phase commonly called the *response.* In terms of stimulus and response, which are actually the initial and final phases of the total functional event, the new learning in transfer experiments is frequently described as learning to make a new response to an old situation, or learning to make an old response to a new situation.

In the card-sorting experiments, mentioned above in connection with negative transfer, when, after practice with one arrangement of the boxes, the arrangement was changed for the transfer trials, the subject had to learn to make different movements upon seeing the numbers of the cards. The functions here were alike in initial phase (seeing the number on the card) but different in the efferent phase (movements). Of course, since it is the positions of the boxes that have been interchanged, a movement to a certain position in the new arrangement is really an old movement made to a different stimulus. Whether we have an old response to a new stimulus or a new response to an old stimulus depends on whether we are considering the common stimulus factors or the common response features of the practice and test performances.

Transfer effects under several variations of identity and similarity with respect to stimulus and response were studied by Bruce (12) in an experiment involving paired-associates learning. The training series consisted of a list of paired nonsense syllables. This was presented either zero, two, six, or twelve times. Then a test list was presented as many times as were required for one perfect reproduction. The lists for the test series contained syllables which bore varying degrees of resemblance to those of the training series. In some cases all three letters of the stimulus or response syllables were the same (identical); in other cases only the first two letters were alike (similar). The relationships of the two series included identical stimulus syllables with different response syllables, identical response items with different stimulus items, and various other relationships of similarity and identity.

The transfer results varied for the various relationships and with the number of presentations of the training series. Thus, the degree of learning appears to be an important condition of transfer. We shall consider this factor more fully in a later section. With twelve presentations of the training series the greatest amount of transfer appeared when the two response items were identical and the second stimulus syllable was similar to both response syllables. Relatively large amounts of transfer appeared when the response syllables of the training and test series were identical and the two stimulus syllables were similar to each other; and also when the two response syllables were identical and the two stimulus syllables were different. Less transfer was found when the two response syllables were identical and similar to the stimulus syllable of the training list, and when the two stimulus members were identical and the two response members were similar to each other. The transfer was comparatively small when the stimulus members of the two series were identical and similar to the response syllable of the training series. When all terms of the training and test series were different, there was a fair amount of positive transfer, but when the stimulus members of the two lists were identical and the response terms altogether different, the transfer was negative. The transfer effect was slightly negative when the stimulus terms were identical and similar to the response syllable of the second list.

These results are important because of what they show regarding the relation of identical components to transfer. The mere presence of common components does not assure positive transfer; under some conditions of training they produce negative transfer. The amount of transfer due to identical features of two functions varies with the locus of identity or the phases of the functions in which identity occurs. The data under consideration show, for example, that identity in the response phases is conducive to far more positive transfer than identity in the stimulus factors or initial phases. Thus, it is easier to learn to respond to a new situation in an old way, than to develop a new mode of responding to an old situation, for in the latter case the interference from previously formed habits is greater.

Various other experiments have shown that the more the trained and test functions have in common the greater tends to be the amount of positive transfer, although the mere fact of identical components in the objective learning situation or materials does not insure positive transfer. In motor functions the compatibility of the habits as well as common components of the stimulus patterns is a determining factor (47).

Transfer by similarity. In the experiment above the syllables designated as similar were identical in two letters out of the three. Here was partial identity of the stimulus-patterns and similarity with respect to the syllables taken as wholes. When functions are similar by partial identity, we may get positive transfer from one to the other as we have seen in the preceding section.

Several experiments have shown that when a subject learns to make a particular response to a given stimulus-situation, he tends to make that response to similar situations, and the frequency with which the trained response is made to the new situation varies with the degree of similarity between the old and the new situation. Thus, it has been frequently demonstrated in experiments on conditioning that if a subject is conditioned to respond to stimulus A, he will without training with stimulus B respond to the latter as he learned to respond to A if the two stimuli are similar. For example, the dog trained to respond by salivation to one musical note, responded also to another of higher pitch; and in Watson's experiments with infants, the child that was conditioned to fear a white rat also showed signs of fear when other furry animals and objects were presented.

It has been demonstrated that subjects who have learned to respond to a stimulus word by another word tend to give the same response word when a word similar in *meaning* to the original stimulus word is presented. The frequency with which a trained verbal response will occur in this manner varies with the degree of the similarity in meaning of the two stimulus words. Thus, if the subject is trained to respond to the word *snake* by saying "tree," he will be more likely to say "tree" in response to *serpent* than to the word *hen* (55).

Transfer by generalization. When a given response is made to varied, though somewhat similar situations, we have a form of generalization of the conditions which initiate the function. In such cases the effects of learning are seen to reach beyond the specific function trained to others of a similar kind. Moreover, as we move to the level of comprehension, we find that generalizations furnish a ready vehicle for transfer. The child who from numerous experiences with dogs has formed a good general concept of dogs readily recognizes a strange animal of that species as a dog. If one has learned the general nature of rivers and comes in his travels upon one he has never seen before, he knows it is a river. Likewise, a child who learns to add with one set of exercises, if he acquires an understanding of the principles involved, will be able to add other sets of figures not used in his training exercises. We have seen above that subjects who grasped the principles involved in solving certain types of mechanical puzzles could more easily solve other puzzles to which these same principles applied.

The importance for transfer of generalized experience was early recognized and emphasized by Judd. He believed experience in one situation could be generalized and applied by the learner in many other situations. In an experiment demonstrating his view he had two groups of boys shoot darts at a target submerged in water. Because of refraction of the light the target appeared to be not in its true position. Before practice the principle of refraction of light was explained to one group, while the other group received no instruction in this matter. Both groups made similar errors at first and corrected them gradually by trial and error. Then the depth of the target was changed. This time the instructed group saw the application of the principle to their problem and did much better than the group that had not been told about light refraction (28).

A similar experiment was made more recently by Hendrickson and Schroeder (25) who had their subjects shoot BB shot at a submerged target with an air rifle. The results were substantially the same, though they found that the theoretical information also aided in learning to hit the target in the initial situation.

The importance of general principles for transfer was shown also by Woodrow in the experiment on memorizing, mentioned previously, in which the group that was taught the principles of good memorizing procedures showed a large degree of transfer while the group that had only routine practice showed practically no transfer.

Transfer through generalization is not merely a matter of elements trained during practice appearing as actual components of the new functions. The generalization is a form of comprehension which applies beyond the training situation to other situations of the same general class. It should be noted, however, that the mere knowledge of the principle will not insure transfer of training to new situations. Its general applicability must be realized, and the learner must be able to see the possibility of its application to the new situations (5).

Transfer through attitudes and ideals. An important form of generalization through which transfer takes place is the generalization of set in the form of attitudes and ideals. Bagley many years ago called attention to the possibilities of transfer *via* this medium. His views (3), and the experiment by Ruediger (37) on training school children to be neat, were mentioned in chapter XVII. As stated there, it was found that when neatness was made a general aim (ideal) in connection with one school subject, the improvement, though greatest in that subject, did carry over to other school subjects.

The keynote of the chapter on attitudes and ideals was the importance of developing these generalized controls of conduct to insure socially acceptable forms of behavior in the many and varied situations of life for which specific habit training would be impossible. In that chapter we considered the widespread influence of these generalized sets. One's reaction to practically any new situation is influenced by attitudes already formed. The bearing on classroom learning of such attitudes as likes, dislikes, respect, antagonism, interest, indifference, punctuality, carelessness, self-confidence, self-repudiation, courtesy, arrogance, pride in work, fear of failure will be apparent to the most casual observer.

The degree of learning as a factor in transfer. In the section on negative transfer, reference was made to Pyle's observation that in the establishment of two incompatible habits less mutual interference is encountered when one is practiced thoroughly before practice on the second is begun than is encountered when both are learned together by alternating practice. This suggests that the greater the amount of training in a given function the less will be the negative transfer effect of the training.

Not only has this proposition been supported by later evidence, but it has also been demonstrated that as the amount of training increases, the amount of positive transfer tends to increase. This was clearly revealed in the experiment by Bruce (12) mentioned above. Of nine relationships of similarity and identity between the training and test lists of paired nonsense syllables studied, when the training list was presented twice, there was negative transfer in six. With six presentations of the training list three of these negative cases shifted to positive transfer, and the amount of negative transfer was less for the remaining three. With twelve presentations only two of these conditions showed negative transfer, and the amount was less in these cases than it was for six presentations. In the case of two conditions which showed positive transfer after two presentations the amount of positive transfer was increased as the number of presentations was increased to six, and to twelve.

Other studies have shown negative transfer when the training was meager, and positive transfer when it was more extensive. In the submerged target experiment by Hendrickson and Schroeder (25) the explanations of light refraction differed in completeness for two experimental groups. The group that received the fuller explanation showed greater gains from transfer. These findings lead to the definite conclusion that partial or superficial learning is more likely to interfere with other learning than is complete mastery, and that for maximum returns in the way of positive transfer effects thorough training is needed.

The time factor in transfer. Studies of the relation of the length of the interval between training and the transfer test or second learning have indicated that the amount and direction of transfer effects are in part dependent on this temporal factor. When training in one habit is followed by training in an antagonistic habit, the amount of negative transfer tends to decrease with an increase in the interval between learning the first and learning the second. In one experiment in which rats were first trained to swim to the right in a "T" maze and later trained to swim to the left in the same maze, the transfer effects were negative when the second habit was learned immediately after the first and also after two and seven days, but positive when it was learned after intervals of fourteen and twenty-eight days (14). It appears that the factors causing interference are forgotten faster than the factors making for positive transfer, and that while the negative factors predominate at first, their more rapid decline eventually brings the positive ones to ascendency.

It has also been demonstrated that, under some conditions at least, transfer effects are more persistent than the direct results of learning. With human subjects in a rational learning experiment it was found that, while there was with the lapse of time a loss in retention for the materials learned, there was, according to the measures used, practically no loss in transfer effects after varying intervals up to ninety days (13). Similar results were obtained in another experiment in which paired nonsense syllables were memorized (15).

It may well be, as McGeoch (31) has pointed out, that the transfer in these cases was due mainly to such general factors as adjustment to the experimental situation, self-confidence, and methods of procedure, and that these general factors are retained better than the specific items learned during training. This view is consistent with other evidence indicating the relatively greater persistence of the generalized products of learning as compared with the specific outcomes.

The relation of the age of functional tendencies to their transfer effects was investigated by Britt (9). His study had to do with the learning of two stylus mazes. Ninety subjects were employed, and these were divided into three groups. The first group learned maze I, and after forty-eight days relearned it just before learning maze II. The second group learned maze II immediately after the first learning of maze I. The third group which served as a control learned only maze II. In learning the test maze, the first group was definitely superior to both the others. The second group did only slightly better than the control. The author concluded that "if the associations for a learning problem are of the same strength but are of unequal age, the older association is more subject to positive transfer to a second problem than is the younger association." Actually, of course, more time was spent learning the training maze by the first group than by the second. The results indicate the importance of reviews for maximum return by way of transfer.

TRANSFER IN SCHOOL SUBJECTS

We have relied chiefly upon the products of laboratory investigations for the facts and conditions of transfer because these investigations yield the most precise and reliable analysis of the problem. They have served to establish the general principles of transfer. We must now turn to the studies that show how these principles operate in the case of classroom learning. The investigations dealing directly with school learning have been concerned with the effect of studying certain subjects on general or special mental abilities and on the learning of other school subjects.

The disciplinary values of high-school subjects. Of the many studies concerning transfer in school subjects the most crucial test of their general disciplinary values was made by Thorndike (44) in 1922 and 1923. Tests of general mental ability were given to 8,564 high-school pupils in grades IX, X, and XI, and after one year of schoolwork other forms of the same tests were given to discover the intellectual advancement made. By a thoroughgoing analysis of the many different combinations of subjects studied, and by a system of weighting the gains to allow for practice effects of taking the tests, for the normal intellectual growth over a year's time, for the fact that pupils with highest initial ability made greatest gains, and also for the fact that the boys gained more than the girls, it was possible to calculate the relative amount contributed by various subjects to the year's gain in the tests. The procedure was to compare the test gains in relation to programs that were alike except for a difference in one subject. If, for example, the programs of two groups, equated in terms of initial test scores, were alike in that they both included English, history, and geometry, but different in that for the fourth subject one group took Latin, while the other took chemistry, then it was possible to compare the contributions of Latin and of chemistry to the test gains. The results were most significant. They revealed surprisingly small differences between the various subjects in relation to the test gains, and they showed the gains to depend more on initial ability or intelligence than upon any particular subject studied.

A similar study with 5,000 pupils was made later (11). The results agreed for the most part with those of the earlier study. The table below represents the combined results of the two studies and covers data from over 13,000 high-school pupils. It shows the subjects listed in rank order according to their computed relative contribution to the gains in the mental ability tests. The scores represent corrected weighted average differences between group VII and each of the others. They show how much the subjects of the various groups exceeded or fell short of those in group VII.

	Subject	*Relative effect on test gains*
1.	Algebra, geometry, trigonometry	2.99
2.	Civics, economics, psychology, sociology	2.89
3.	Chemistry, physics, general science	2.71
4.	Arithmetic, bookkeeping	2.60
5.	Physical training	0.83
6.	Latin, French	0.79
7.	English, history, business, drawing	0.00
8.	Stenography, cooking, sewing	−0.14
9.	Biological sciences, agriculture	−0.48
10.	Dramatic art	−0.48

The differences are so slight that there is no convincing evidence of the superiority for mental discipline of any one subject or group of subjects. It is significant that Latin, so long held up as the supreme instrument of mental discipline, should, when subjected to a fair comparison with other subjects, fall to the middle of the list.

In discussing the outcomes of his investigation Thorndike states: "After positive correlation of gain with initial ability is allowed for, the balance in favor of any study is certainly not large. Disciplinary values may be real and deserve weight in the curriculum, but the weights should be reasonable" (44*a*).

Studies of transfer in special subjects. *Arithmetic.* One investigator found that practice in arithmetical computation, which improved the accuracy in the computation processes, did not improve arithmetical reasoning. This finding was based on tests given to two groups before and after one of the groups had received practice in computation exercises (50). We should expect, however, transfer from training in computation to *learning* to solve reasoning problems in so far as the trained computation processes entered into the actual solving of the reasoning problems.

Overman (35) investigated transfer in arithmetic in relation to methods of teaching. His subjects were pupils of fifty-two second-grade classes. They were divided into four closely equated groups of 112 each. The training consisted of instruction and practice in addition with three types of examples involving two-place numbers. Tests were given to determine the extent to which this training transferred to similar addition examples involving two-place and three-place numbers and to examples in subtraction. Group A was shown simply how to do the examples with no attempt to generalize the procedure or to develop comprehension of the underlying principles. In group B *generalizations* of the procedure were stressed and an effort was made to formulate rules applicable to similar types of examples. With group C no attempt was made to generalize or formulate rules, but the reasons for the procedures in the specific examples were discussed. In group D the methods of B and C were combined.

The tests given before and after training showed a considerable amount of transfer for all four groups from the taught to the untaught examples. It varied from sixty-seven per cent to eighty-one per cent for the different types of problems. The calculated transfer (on the basis of 100 per cent for correct solution of all untaught problems) was 59.6 per cent for group A. That generalization greatly facilitated transfer was shown by the fact that group B surpassed group A in the untaught examples by 21.5 per cent. This difference was statistically significant. Discussion of the underlying principles and reasons for the procedures in the taught examples appeared to contribute little to transfer, for group C surpassed A by only 5.4 per cent, and the difference was not significant. Group D did about the same as group B, surpassing group A by 20.5 per cent. It appeared, therefore, that "rationalization" added nothing to "generalization."

Geometry. The transfer values of a college freshman course in descriptive geometry were investigated by Rugg (39) at the University of Illinois. The training group consisted of 326 freshman engineering students who took the course, while eighty-seven students in the college of liberal arts were used as a control group. Tests were given to both groups at the beginning and at the end of the semester during which geometry was studied by the training group but not by the controls. These tests dealt with three types of material: first, "non-geometrical"; second, "quasi-geometrical"; and third, "strictly geometrical." The gains of the training group in the tests were greater in all three types of material than for the control group. This difference in gains for the two groups indicated transfer from the semester course in geometry. But the amount of transfer varied for the three types of test material, being seven per cent for the non-geometrical, twenty per cent for the quasi-geometrical, and thirty-one per cent for the geometrical. When the amount of transfer was studied in relation to scholastic ability, the amount of transfer was found to correspond to ability in mathematics, but it did not correspond to differences in ability in English and modern languages. Here again it appears that transfer takes place according to the amount of similarity between the trained and untrained processes, and to the extent to which procedures of analysis and attack are generalized.

Algebra. An arithmetic test covering the fundamental operations, percentage, and problem solving was given to a group of about two hundred pupils before and after taking a course in ninth-grade algebra. There appeared to be a definite improvement in the arithmetical abilities tested, but since no control group was used, it is not possible to say just how much of this improvement was directly attributable to the study of algebra (6).

Chemistry. A study in the field of high-school chemistry showed that students who were given special training in the application of principles derived from the kinetic theory gained more in tests involving the application of other chemical principles than did members of control groups who had the usual instruction. The groups were too small to make the results statistically reliable, but the data indicate that the amount of transfer secured for applying scientific principles in new situations is related to the teaching procedures employed, and that it may be increased by means of special training in the application of principles (2).

Grammar. The alleged values of formal grammar for developing various types of abilities such as reasoning in other fields were examined by Briggs (8). The subjects were seventh-grade pupils. They were divided into two equivalent groups on the basis of intelligence ratings. One group studied grammar while the other studied composition and language. The before and after tests measured the pupils' ability to see likeness and differences, to test definitions critically, to apply definitions, to make a rule or definition, and to reason in connection with various matters. With the possible exception of detecting likenesses and differences, the results indicated that there was no gain of any consequence in those aspects of the reasoning processes tested that could be attributed to the study of grammar.

Latin. The blasting of the doctrine of formal discipline by experimental evidence discredited the view that Latin is a superior means for "developing the mind." This led to a search for evidence of transfer values to be derived from the study of this language. No one who has studied this problem carefully will deny that the study of Latin has transfer values. What is objected to and what has been disproved is that this subject has a monopoly on transfer values or that it is particularly superior to other subjects in this matter. The question to be faced frankly is whether a high-school pupil will receive values commensurate with the time devoted to Latin when other subjects also afford transfer or general values plus a much larger amount of directly useful material.

In a study designed to test the value of first-year Latin for ability to read English several thousand high-school pupils were given form 2 of the Thorndike-McCall Reading Scale at the beginning of the school year, form 8 at the end of the half-year, and form 4 at the end of the year. Among those tested were pupils taking first-year Latin and those who were not studying this subject. It was assumed that if the Latin pupils gained more than the non-Latins in the tests their superiority could be attributed to the study of Latin. After taking into account differences in initial scores, it was calculated that the Latin pupils for the entire year gained about 1.5 times as much as the non-Latins. The system of scoring and weighting used gave the Latins a superiority of 1.7 for the whole year, and 1.8 for the first half-year. Thus, the superiority of the Latin pupils was achieved entirely during the first half-year. During the second half-year they gained no more than the non-Latin pupils (42).

Another study was undertaken to determine the influence of the study of one year of Latin on the knowledge of English words. Over 5,000 pupils in ninth-grade classes of forty-one schools in several different states were given forms A, B, and C of the Carr English Vocabulary Test at the beginning, middle, and end of the school year respectively. Each test included twenty-five words derived from Latin, and twenty-five words not of Latin origin. About half of the pupils tested took first-year Latin while the other half did not. In words of Latin origin the Latin pupils made greater gains for the year than did the non-Latin group. For words not derived from Latin the gains of the two groups were approximately the same (43, 45).

Other studies have indicated that the study of Latin contributes to an improvement in English vocabulary according to the amount of attention devoted in the Latin class to the matter of derivation of English words from the Latin. Not much benefit may be derived from the study of Latin on this score unless the teacher definitely gives training in English derivations (27).

It has been shown that the study of Latin for one year produces some beneficial effects on the ability to spell English words of Latin origin, but not for words of non-Latin origin. Here too the method of teaching is an important factor. If no emphasis is placed on spelling, a slight advantage may accrue from the study of Latin. Great emphasis on Latin derivations may even impair ability to spell words not derived from Latin. The most favorable results have been obtained from the development of rules and the comprehension of principles pertaining to the spelling of Latin derivatives (19, 20).

To determine the value of the study of Latin in high school as a preparation for the study of French in college, Kirby (30) compared the grades in first-year French of students who had studied Latin with the grades of students who had not studied Latin. The Latin students made slightly better grades in the first semester of French. He found a correlation of .23 between the number of years spent in studying Latin and grades in French as compared with a correlation of .43 between French grades and intelligence. It appears from this that intelligence had more to do with the French grades than did the previous study of Latin. When the factor of intelligence was kept constant, a correlation of .22 was found for French grades and the years spent in the study of Latin, indicating a slight relationship.

A similar study by Cole (16) likewise revealed a positive relation between the number of years spent in the study of Latin in high school and grades earned by college freshmen in first-year French. In this study a positive relation was found also between the amount of Latin studied and grades in Spanish. Students who had studied Latin for four years made better grades in first-year French and Spanish than students who had studied Latin for two years. Since the factor of intelligence was made constant, these findings indicate some transfer effects from Latin to the study of these modern languages.

Modern foreign languages. Werner (49) investigated the influence of the study of modern foreign languages upon the development of abilities in English. A battery of tests covering punctuation, sentence structure, language and grammar, vocabulary, reading speed, and reading comprehension was given to a large number of high-school and college students at the beginning and at the end of a school year. The gains in the tests made by the students who during the year studied French, German, or Spanish were compared with the gains of those who did not study a foreign language. The results in general indicated: that the study of a foreign language did not always produce an improvement in abilities in English; that such study contributed to the development of speed and comprehension in reading; that it had a favorable effect on ability in grammar for high-school pupils but not in the case of college freshmen; that it had a negative effect on improvement in punctuation and the ability to detect faulty sentence structure; that it had no appreciable effect on the increase of English vocabulary; and that the effect of foreign language study on the development of abilities in English varied greatly with the degree of mental ability, since pupils with high-grade ability more often profited by such study and the less gifted individuals more often suffered from the interference produced by it.

An investigation of the influence of the study of French on the gains in English vocabulary was made by Woody (54). Form I of a specially prepared test of English vocabulary, containing twenty-five words derived from French and twenty-five words of non-French origin, was given near the beginning of the school year to three groups of high-school pupils. One group was made up of pupils who were beginning the study of French and who had not taken and were not taking any other foreign language. The pupils of the second group were not taking and had not previously taken any foreign language. The members of the third group were beginning the study of Latin with no previous or concurrent study of any foreign language. Near the end of the same school year (1926–1927) form II of the vocabulary test was administered to the same pupils. High schools in ten Michigan cities participated in the investigation.

The mean gains of the three groups for words derived from French and for words not of French origin are shown in the following table:

Language Group	*French Derivatives*	*Non-French Origin*
1. No foreign language	2.34	.68
2. Beginning French	1.29	−.08
3. Beginning Latin	2.09	.57

It will be noted that there was a gain in all but one case. The "Beginning French" group showed a slight loss on words not derived from French. The gains in words of French origin were greater for all groups than for non-French derivatives. In both types of words the "No Language" group made greater mean gains than either of the two language groups, and the mean gains for the "Beginning Latin" group exceeded the gains of the "Beginning French" group. It is significant that the French group gained less than the other two groups in words of French derivation, for in these words we should have expected an advantage from their study of French. The factors of sex, size of initial score, and intelligence did not affect significantly the general tendency of the results.

It was suggested that the superiority of the Latin group over the French group may have been due to more attention to the matter of derivation in the Latin classes and to the fact that many words derived from French are also based on Latin roots, and that the superiority of the "No Language" group may have been due to stress on business English and spelling in commercial courses taken by members of this group. The author was careful to point out that the results reflected only the conditions as they were then in the schools studied and that a different emphasis in teaching might well be expected to produce different results. They do indicate strongly that the teaching of French with no particular attention to the derivation of English words from French cannot be expected to contribute much to the development of the pupil's English vocabulary even in the case of words of French origin.

A general consideration of the evidence. These and other investigations of the transfer effects of classroom study agree in general with the laboratory experiments on the fundamental nature and conditions of transfer. They indicate that the training in one school subject transfers to the study of other subjects or to other activities not directly trained, according to the degree of *similarity* between the trained and untrained activities, or according to the extent to which these activities possess *common components,* and according to the extent to which the learner grasps or recognizes such similarities or relationships. They have shown that transfer may be secured by way of *generalizations* in the form of rules and principles when the learner realizes the applicability of such rules and principles to situations or problems other than those specifically involved in his training. They have shown also that the ease and extent of transfer increases with the thoroughness of learning, with the intelligence of the learner, and with purposeful effort on the part of the teacher to secure definite transfer values.

They indicate, moreover, that any subject may, if properly taught, have some transfer or disciplinary values, that the differences between subjects in this respect are small, and that no one subject or group of subjects is superior enough in this respect to justify its study for disciplinary values alone. It appears that the most effective way to secure a desired educational outcome is to train directly for it rather than to expect it to appear as an incidental by-product. The evidence from transfer studies supports the modern educational trend toward the teaching of that which is worth learning for its direct values, be those values social, esthetic, recreational, or utilitarian, rather than for any so-called training of the mind.

Teaching for transfer. That the method of teaching is an important factor in securing transfer from the classroom exercises to situations and activities beyond the classroom has been definitely demonstrated. If pupils are to get the fullest return from the study of a subject, it should be taught in a manner conducive to the maximum of transfer effects. Since transfer takes place through the medium of common components and generalizations, effective teaching will bear on these factors so that the outcomes will not be merely the mastery of the particular exercise for its own sake, but will spread beyond the limits of the particular conditions of the instructional situation to other situations and problems.

We may promote transfer through common functional components by devising learning exercises in keeping with the demands of real-life situations, and by securing problems calling for methods of attack and analysis similar to those demanded by the problems confronted in daily living. The modern trend in arithmetic is in this direction with its emphasis on the achievement of accuracy and speed in the processes required in the transactions most commonly engaged in outside the classroom, and with the dropping out of such rarely used operations as cube root, the greatest common divisor, least common multiple, uncommon applications of percentage, decimals running to six or eight numbers, and compound proportion. In the up-to-date practices conducive to transfer children learn their arithmetic in actual problem situations that are real and interesting to them. Units of study are organized around such real undertakings as building bird houses, making a garden, planning refreshments for a party, and preparing the stage-setting for a play production. In a recent textbook on high-school mathematics a courageous departure from the traditional pattern has been made by organizing the training in mathematical processes around such real-life transactions as buying insurance, buying a home, purchasing and operating an automobile, installment buying, budgeting an income, borrowing money, and paying taxes and other bills (34). From training of this type we may expect far more transfer to actual life situations than from algebra and geometry as they are usually taught.

In other subjects the principle of transfer by way of common components may likewise be utilized to enhance the value of learning outcomes. Some of the ways by which a resourceful teacher can accomplish this are: relating the history lesson to the novel studied in the literature class or to present political problems; relating the geography lesson to travel, to the food on the dinner table, or to the issue of world citizenship; relating the civics lesson to the current town election; relating the elementary science lesson to the family car, the radio, or aviation; relating the foreign language lesson to good English usage; and relating the geometry lesson to finding the range of an enemy target in war, or to the building of a house. The essential thing is to help the learner see the many different situations and activities that contain or involve elements or features of the subject he is studying.

The teacher who desires to have the results of his instruction reach beyond the confines of the classroom, one who seeks to be a true educator, will, moreover, take advantage of the possibilities of transfer through generalization of experience. The principle taught by means of a classroom exercise will be developed to include far more than the specific details of that particular exercise. The learner must see the entire range of situations to which the principle applies. The use of many and varied examples will aid in accomplishing this important step. He must also be shown cases wherein the principle does not apply. If it is multiplication that is being taught, the child must be made to comprehend the correct procedures by various types of examples so that he will be able to solve any problem in multiplication. Instead of requiring a child to memorize by rote a table of meaningless cubic measures, which will be almost immediately forgotten, let him be shown how to find the cube of any number. In an earlier chapter the writer told of a child who was required when in the eighth grade to memorize such a table. At that time he explained to the child what a cube is, and the process of cubing a number. Three years later he asked her how many cubic inches there are in a cubic foot. She could not give the number. Then he asked, "How can you find the correct number?" Immediately she replied, "Multiply 144 by 12." The specific factual item was quickly forgotten, but the principle was retained and could be used not only for this case but also in any case where the cube of a number might be needed.

The procedures for developing generalizations were discussed in the chapter on comprehension. They include calling attention to the principle in numerous and varied concrete cases, and its isolation by way of contrast through the examination of cases to which it does not apply. Only a few suggestions need to be added here. The good teacher will keep in mind that for greatest transfer the generalization should be thoroughly mastered; it should be completely understood. Its application in a great variety of situations and problems will need to be pointed out. The many different ways in which it may be employed in various vocations, in dealing with current social problems, or in managing one's personal affairs should be indicated.

The teacher should also bear in mind the important relations of intelligence to transfer. It is easier for a child of high-grade intelligence to generalize than for one less gifted. The brighter child will be quicker to recognize elements of similarity. He will grasp the underlying principle with fewer illustrations. He will show greater facility in drawing from concrete examples the general procedures and methods appropriate for dealing with other cases. For the child of lesser intelligence, therefore, the teacher will need to intensify his effort to secure an understanding of the range of application and usefulness of rules, laws, definitions, methods of procedure, and other generalizations.

Special attention must be given to techniques of problem solving, to efficient procedures in learning, and to the best methods of dealing with controversial issues. An effort should also be made to develop ideals and attitudes which serve, as we have seen, as generalized controls of thinking, feeling, and conduct. Through these we may expect transfer from the classroom instruction to the diverse situations and activities of life.

Summary of the Chapter

Transfer of training occurs when the results of learning in one situation affect our performance in different situations, or when training in one activity affects other forms of activity. The nature and conditions of transfer are of prime importance to education both with regard to what subjects shall be taught, and to how they shall be taught.

Prior to the present century the doctrine of formal discipline dominated educational philosophy and practice. Subjects were taught primarily for their alleged value for training the faculties of the mind, not for their intrinsic worth to the pupil. This doctrine was discredited by controlled experiments made in the early part of this century.

Many experiments on various functions, particularly action, memory, perception, and reasoning, have shown that transfer does take place, and that it may be negative as well as positive. These studies have been fruitful in discovering the conditions under which transfer occurs. While the greatest improvement occurs from direct training, transfer takes place through the medium of components common to the activity trained and the activity to which the training is transferred. The greater the similarity of two functions the more will the training of one affect the other.

Transfer also takes place through generalizations, developed during training, when the learner sees the applicability of a principle, rule, or method of attack to a new situation or problem. Another medium of transfer is found in ideals and attitudes.

The degree of learning is a factor in transfer. As it is increased, the tendency toward negative transference or interference is lessened and the tendency toward positive transfer is increased. There is some evidence that transfer effects are more persistent than the direct results of training.

Studies of transfer in school subjects indicate only small differences between high-school subjects in their effect on general mental ability. Studies of special school subjects indicate that the study of one subject may affect the ability to learn other subjects, but that the amount and nature of transfer effects depend upon the intelligence of the pupil and the method of instruction far more than it does upon the subject.

The evidence, in general, points to the conclusion that the most effective way to realize a desired educational outcome is to train directly for it, and that no subject merits a place in the curriculum solely on the grounds of its alleged values for mental training. Any subject properly taught has cultural, disciplinary, and transfer values. The direct values, therefore, are to be given the first consideration.

Every subject should be so taught as to secure the maximum spread of learning to situations and activities beyond the classroom. To this end attention should be called to those aspects of the subject that are common to other subjects and to the various activities in which elements of the subject are employed. Generalizations should be thoroughly taught, and the varied possibilities of their use and application pointed out to the learner. In teaching for transfer we should endeavor to develop attitudes and ideals.

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